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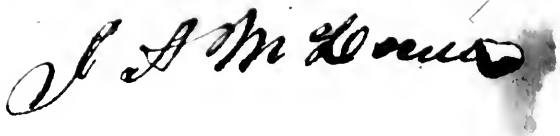

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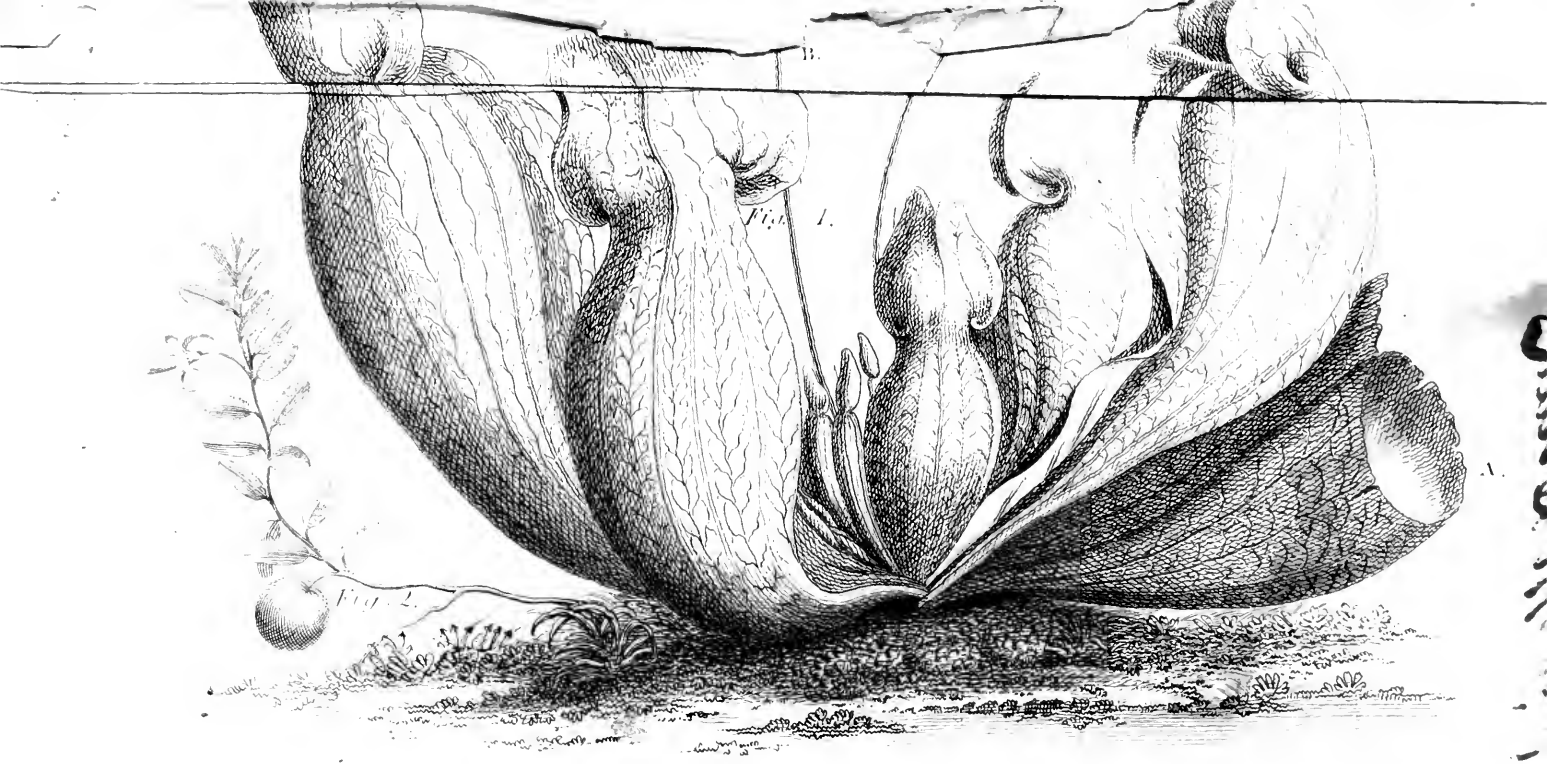

Class XIII.

ELEMENTS OF BOTANY:

OR

OUTLINES OF THE NATURAL HISTORY

OF

VEGETABLES.

ILLUSTRATED BY FORTY PLATES,

BY BENJAMIN SMITH BARTON, M. D.

President of the Philadelphia Linnean and Medical Societies; one of the Vice-Presidents of the American Philosophical Society; Member of the Imperial Society of Naturalists at Moscow in Russia; and Professor of Materia Medica, Natural History and Botany, in the University of Pennsylvania.

THE THIRD EDITION,

CORRECTED AND GREATLY ENLARGED.

IN TWO VOLUMES.

VOL. I.

Philadelphia,

PUBLISHED BY ROBERT DESILVER,

No. 110 *Walnut Street.*

1827.

DISTRICT OF PENNSYLVANIA, TO WIT:

BE IT REMEMBERED, That on the thirteenth day of February, in the thirty-sixth year of the Independence of the United States of America, A. D. 1812, Benjamin Smith Barton, M. D. of the said district, hath deposited in this office, the title of a book, the right whereof he claims as author, in the words following, to wit:

"Elements of Botany: or Outlines of the Natural History of Vegetables. Illustrated by forty plates. By Benjamin Smith Barton, M. D. President of the Philadelphia Linnean and Medical Societies; one of the Vice-Presidents of the American Philosophical Society; Member of the Imperial Society of Naturalists at Moscow in Russia; and Professor of Materia Medica, Natural History and Botany, in the University of Pennsylvania. The third edition, corrected and greatly enlarged. In two volumes. Vol. I."

In conformity to the act of the Congress of the United States, intituled, "an Act for the encouragement of learning, by securing the copies of maps, charts, and books, to the authors and proprietors of such copies during the times therein mentioned." And also to the Act, entitled, "An Act supplementary to an Act, entitled, "an Act for the encouragement of learning, by securing the copies of maps, charts, and books, to the authors and proprietors of such copies during the time therein mentioned," and extending the benefits thereof to the arts of designing, engraving, and etching historical and other prints."

D. CALDWELL,
Clerk of the District of Pennsylvania.

TO THE

STUDENTS OF MEDICINE,

IN THE UNIVERSITY OF PENNSYLVANIA;

AND TO THE

LOVERS AND CULTIVATORS

OF

NATURAL HISTORY,

IN EVERY PART OF THE UNITED-STATES,

THESE

ELEMENTS OF BOTANY

ARE VERY RESPECTFULLY INSCRIBED,

BY

BENJAMIN SMITH BARTON.

Philadelphia, February 28th, 1803.

UNIVERSITY OF PENNSYLVANIA.

The Lectures on MATERIA MEDICA, and those on NATURAL HISTORY*, commence, annually, in the first week of November, and terminate in the first week of March.

* These are two distinct Courses of Lectures.

PREFACE.

IN the year 1789, the Trustees of the College of Philadelphia instituted a PROFESSORSHIP OF NATURAL HISTORY AND BOTANY. I was honoured with the appointment of teaching these branches of science, the first of which had never before been taught in the Institution*. Upon the union of the College with the University of Pennsylvania, in the year 1791, my former appointment was confirmed by the trustees of the united institution; and in the year 1796, I received a new mark of the attention of the trustees, by their appointing me to fill the chair of MATERIA MEDICA, which was rendered vacant by the resignation of the professor of that branch of medical science.

THE different branches of Natural History, particularly Zoology and Botany, have been my favourite studies, from a very early period of my life. The happiest hours of near sixteen years of cares, of difficulties, or of sickness, have been devoted to the cultivation of these interesting sciences. During this long period, I have never ceased to look forward, as I still look forward, with an ardent satisfaction, to the time, when Natural History shall be taught as an indispensible branch of science, in our university: when it shall

* Several courses of lectures on Botany had formerly been delivered, in the College of Philadelphia, by Dr. Adam Kuhn, one of the pupils of the great Linnæus.

cease to "yield its laurels to languages which are wither-"ed or dead, and to studies, that are useless or ignoble*."

That period has not yet arrived. I have, however, the satisfaction of observing, that these sciences are making some, nay even great, advances among us; and I still flatter myself, that the directors of our principal American universities, or other seminaries of learning, but, in particular, the Trustees of the University of Pennsylvania (IN WHICH ALL THE BRANCHES OF MEDICAL SCIENCE ARE TAUGHT MUCH MORE EXTENSIVELY THAN IN ANY OTHER PART OF THE UNITED-STATES), will see the propriety, and even necessity, of giving more substantial encouragement for the extension of Natural History among us.

It was with the view of contributing something to this desirable end, that I undertook the arduous task of composing these Elements of Botany: a task certainly arduous for one who is engaged in the practice of an anxious and difficult profession; occupied for near seven months of the year in the duties of teaching in the University, and, withal, subject to repeated attacks of a violent and dangerous disease. The work is now presented to the public. I cannot but be somewhat solicitous about it: I cannot "dismiss it with frigid tranquillity†:" but I will not tremble for its fate. Should the work confer no reputation upon me, I am still young enough to hope, that reputation may be obtained by future efforts.

* See Fragments of the Natural History of Pennsylvania. Part I. Int. p. viii.

† Dr. Johnson.

I HAVE divided this work into three parts. In the First Part, I have given a pretty extensive DELINEATION OF THE PLANT, beginning with the root, and ending with the various organs of the fructification. The terminology, or nomenclature, of all these parts is amply detailed; indeed, I fear much more amply than may seem agreeable to some of my readers. But as one of the great objects of the botanist is the correct or discriminative description of plants, and as such a description cannot be given without the use of an appropriate language (such as the modern botanical language, unquestionably, is), I shall offer no apology for my having taken up so much time in the mere description of the various parts of the vegetable. If those, whose object is a more superficial acquaintance with the study of plants, should feel somewhat fatigued, in pursuing me through such a laboured range of words, I am persuaded, on the other hand, that some of my readers will feel a regret, that this terminology is not still more extensive.

BUT, in this first part of the work, I have not confined myself entirely to the technical portion of my subject. Various circumstances relative to the physiology, the economy, the uses, &c., of vegetables, are, likewise, introduced. And although some of these circumstances might, perhaps, with more propriety, have been reserved for the second part, I flatter myself they will not appear entirely out of place, where I have introduced them. I am, at least, persuaded, that they will serve to amuse and relieve the reader, in the midst of that fatigue, and, possibly, disgust, which the learning of a

new language is too well calculated to excite. The classical reader will not, I think, be displeased at my frequent references to passages in the works of the Roman writers, particularly their poets. I have introduced these passages*, because they often serve to illustrate my subject, and because they cannot fail to enliven it. Although I am of opinion, that, in many of the American seminaries of learning, the study of the languages of ancient Greece and Rome, has occupied too large a share of the time and attention of youth, to the exclusion of more important studies, I am far from coinciding in sentiment with certain American writers, who have laboured to effect the complete banishment of these languages from our schools. An entire neglect of the Latin language, in particular, will emphatically mark the era of the decline of genuine taste, among a people.

The study of Vegetable Physiology has long been one of my most favourite pursuits. I have always considered it as the richest portion of Botany. I believe its practical tendency, is highly important. It was originally my intention to have given, in the Second Part of these *Elements*, a general view of the principal subjects in the physiology of vegetables. But I soon found, that this scheme must be deserted, as I had gradually drawn myself into an extent of discussion (with respect to the subjects that are involved in the first and third parts of the work), which I had but little contemplated†. This must serve as my apology for the deficien-

* Not only in the First but also in the Third Part.

† My original proposals were to furnish a volume of, at least, two hundred and eighty pages, with eighteen plates. It is unnecessary to say, how much the work

cies and imperfections of the second part of the work. To supply, in some measure, these deficiencies and imperfections, I design to publish a Supplement to these *Elements*, in which the physiology of vegetables will be *principally* considered. I cannot pretend to fix upon the precise time at which this supplement shall appear. But, should the state of my health permit me to devote the necessary attention to the subject, I may hope to publish it in the course of the ensuing summer or autumn. It will consist of about one hundred and sixty pages, and will be illustrated by a few necessary plates.

In the Third, and last, part of this work, I have principally confined myself to an exposition of the Sexual Method of Linnæus; to the natural orders (as they are called) of the same author, and have given notices concerning the natural and artificial methods of other botanists, from the time of Cæsalpinus to the present day*. Much of originality, or even of innovation, will hardly be expected in this part of the work. It will readily be observed, however, that I have taken some liberties with the Linnean arrangement of certain genera, particularly in the class Gynandria, where I have followed the disposition of the learned Mr. Swartz, one of the most distinguished botanists of Europe.

If in the discussion of the subjects which are involved in the third part of the work, the reader meet with any thing strictly new, it is principally in what regards the

has been extended beyond the limits of this plan. For particular reasons, I think it proper to add, that the whole of the first, and the greater portion of the third, part of the work were printed off, before any of the pages of the second part were committed to the press.

* See Appendix.

*ology of Vegetables**, I had not an opportunity of seeing any part, until I had printed off a great part of my work. Many other works, as well nomenclatural as physiological, which would have been of great service to me, have never reached me. However, in the Supplement which I propose to publish, I shall endeavour to avail myself extensively of these various helps.

For some of the imperfections of this work, I may, perhaps, claim the indulgence of the public, on a ground, which, to me at least, is interesting. A very infirm state of health, which would, perhaps, rob any one (however ardent in the pursuit of science) of a portion of his zeal; and would, necessarily, abridge the hours of his intellectual labours, has long been, and continues to be, my companion. With respect to this very work, I may complain, almost without a metaphor, in the words of Linnæus (there is even no necessity to change the name of the disease): "At dira *arthritis*, vix incepto opere, ita una cum corpo-"ris viribus mentem et animum fregit, ut in ipsa herba "fere suffocatum fuisset†."

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* Physiologie Vegetale; contenant une description des organes des plantes, et une exposition des phenomenes produits par leur organization. Par Jean Senebier. A Geneve.

† Philosophia Botanica, &c. Praefatio—Viennæ: 1783.

PREFACE

TO THE SECOND EDITION.

THE former edition of this work, though written under many disadvantages, has, upon the whole, been favourably received by the public. It has been republished in Britain, and has met with some flattering marks of attention on the continent of Europe. Among my own countrymen, for whom it was especially composed, it has not been neglected. It has, indeed, if I mistake not, been the principal *Elementary* work on Botany that has been in the hands of my pupils, and the students of this interesting and amiable branch of natural history, in almost every part of the United-States, since the year 1803.

A NEW edition of the work is now presented to the public. This edition is much more extensive than the former; and though still very imperfect, and deformed, I fear, by many errors, I may venture to assert, that it is greatly amended, in many respects; and in all respects more worthy of the attention of the students and lovers of Botany, and especially of the young botanists of my own country.

IT may not be improper to mention, in this place, the principal points of difference between the present and the former edition.

The first part of the work, which forms the great mass of the first volume*, remains pretty much in the same state in which it originally came from the press. Several additions, however, have been made to the *body* of this part: some errors have been corrected. Some notes, chiefly illustrative of the text, are added; and these, from their miscellaneous nature, will, I hope, be deemed acceptable to the curious reader. They may serve to enliven the subject, and convey to him some idea of the manner in which I treat the science of botany, in my public lectures.

The two plates† representing the principal forms of Leaves, both simple and compound, and also plates xxxiv and xxxv, which are attached to this volume, are entirely new additions. They are accompanied by a copious explanation: and the explanations of the other plates, though not wholly new, are more full than in the former edition.

But the most important addition to the first volume, the plates of the leaves perhaps excepted, is the copious Index, which terminates the volume. This index will, I am persuaded, be deemed a valuable supplement to my work: for the want of it was much complained of by the purchasers of the first edition. It is principally intended as an index, or catalogue, of the terminology, or technical terms, that are made use of in every part of the work. In this respect, if I do not mistake, it is so extensive and complete, that it may supply the want of some of those *mere* botanical dictionaries, which I have referred to, in the body of the work.

* The first edition of the work was generally comprized in one volume, but was sometimes formed into two. The present, from its increased size, is necessarily distributed into two volumes.

† Plates xxxii, xxxiii.

This index also contains a list of all the Natural Orders, or assortments, of plants that are mentioned, either incidentally or more particularly, in the two volumes: but it contains no references to individual plants. It embraces, also, references to *many* of the principal miscellaneous subjects of my work. But, I repeat it, I wish it to be considered chiefly as an index of technical terms.

The second part, though still small in comparison of either the first or the third parts, is somewhat corrected, and considerably enlarged. In particular, it contains a section, of some length, on the Generative functions of the stamens and the pistils; including observations on the irritable movements of these sexual organs, &c., &c. I have, also, added a short section on the chief Principles contained in vegetables; and, at the end of the part, a small body of notes.—I should have greatly enlarged this portion of the work, had I not been unwilling to increase, beyond certain limits, the size of the volume; and were it not still my intention to publish, at some future period, a *small* volume on the Physiology of vegetables, somewhat upon the plan which I have mentioned in the Preface to the first edition*.

But it is in the third and last part of this work, that the reader will find the most important corrections and additions. Indeed, throughout the whole of this portion of the volume, additions and corrections have been made. Many of the genera are now disposed of very differently from what they were in the former edition. In many instances, I have, also, added remarks on the anomalies of the stamens, in regard to number, insertion, &c.: and these re-

* See page ix.

marks, especially when I speak of the North-American plants, will, perhaps, be considered as a *morceau* of some value to systematic botanists.

All the observations on the Algæ, Fungi, Palmæ, &c., &c., after page 168, and between this and the *Appendix*, are new additions. To the appendix itself, I have made some additions: as well as to the explanations of some of the thirty plates, which were included in the first edition of the *Elements*. The new plates, of which mention in presently to be made, are of course accompanied by new explanatory matter.

The volume is terminated by an Index of the principal vegetables which are mentioned in the work, and especially in the third part. In this index, both the scientific and English and provincial names of the plants are given: and although this catalogue is less extensive than I could wish it were, it cannot fail to be of essential use to the student in aiding him in his investigations into the position or arrangement of many of the plants, concerning which he may wish to obtain information.

The first edition of this work contained thirty plates: the present is enriched by ten additional plates. Some of these will, I flatter myself, be found valuable and important; or at least of great use to the young student of botany. They are all *original* plates, and some of them after drawings done by artists of the first character. Such, in particular, are plates xxxi, xxxii, xxxiii, xxxiv, xxxvi.

Besides the addition of these ten new plates, important additions have been made to some of those which accompanied the first edition of the work. Such additions will

be found in plates v, xiv, xx, xxi, xxvi, and xxx: and others of the plates, to which no additions, properly so called, have been made, have been, in some measure, improved by the hand of the engraver. Plate i, in particular, is materially improved.

* * * * * *

It now only remains for me to request a candid examination of this work by the public; and especially by those to whom the number and variety of my professional engagements, and of my literary pursuits, may not be known. It is a fact, that the work, originally begun and written in sickness, has been carried on to its present improved and enlarged state, in the intervals between my laborious attentions to the duties of my profession as a physician, and those as a lecturer on three great branches of science in the University; on Materia Medica, Botany, and Zoology; and while I have been occupied in attending to the printing of several other works, much more original in their nature, and from which I venture to promise myself a more solid reputation: viz. two distinct *Floræ*, one of six of the states of the American Union*; one of the state of Virginia†: a work on the Geography of the North-American trees and shrubs; an elementary work on Zoology; and, lastly, a volume on the original, the migrations, the religious and political institutions, the languages, &c., of the Indians of North-America; besides some memoirs on minor or more individual subjects. All these works are actually, *at this time*, in the press: and some of them are nearly finished.

* Prodromus of a Flora of the states of New-York, New-Jersey, Pennsylvania, Delaware, Maryland, and Virginia: illustrated by plates.

† Flora Virginica, &c.

To my Pupils, whether those who have been under my immediate direction, or those with whom I have had merely intercourse in my capacity of a public professor, I offer no formal apologies for the imperfections of this work. Most of my *Elèves* have manifested a disposition to view my literary labours with tenderness and candour: and from many,—very many,—of them I have received acts of kindness, of friendship, and almost filial affection, which have constituted not a little of my happiness; and the remembrance of which,—if memory remain,—will not fail to cheer and solace me in the most gloomy walks to which I may be destined, in the remainder of my life.

March 27th, 1811.

ELEMENTS OF BOTANY.

PART FIRST.

" But not alike to every mortal eye
" Is this great scene unveil'd. For since the claims
" Of social life, to different labours urge
" The active powers of man; with wise intent
" The hand of NATURE on peculiar minds
" Imprints a different bias, and to each
" Decrees its province in the common toil.
" To some she taught the fabric of the sphere,
" The changeful moon, the circuit of the stars,
" The golden zones of heaven: to some she gave
" To weigh the moment of eternal things,
" Of time, and space, and fate's unbroken chain,
" And will's quick impulse: OTHERS BY THE HAND
" SHE LED O'ER VALES AND MOUNTAINS, TO EXPLORE
" WHAT HEALING VIRTUE SWELLS THE TENDER VEINS
" OF HERBS AND FLOWERS; OR WHAT THE BEAMS OF MORN
" DRAW FORTH, DISTILLING FROM THE CLIFTED RIND
" IN BALMY TEARS. But some to higher hopes
" Were destin'd."——

THE PLEASURES OF IMAGINATION.
Book I. l. 79---97.

ELEMENTS OF BOTANY.

" Nec dubitamus, multa esse, quæ & nos prætererint. HOMINES ENIM SUMUS & OCCUPATI OFFICIIS."
C. PLINII SECUNDI
Naturalis Historiæ Lib. I.

LINNÆUS has made a general division of the plant, or vegetable, into three parts, viz. the RADIX, the HERBA, and the FRUCTIFICATIO. Of each of these parts, and of their various subordinate divisions, I shall speak in the order in which I have mentioned them. I prefer this order in treating my subject, as being more natural, or at least more facile and more simple, than that of those writers who begin their delineation of vegetables with an account of the fructification. In the very commencement of my subject, at least, I follow the "SWEDISH SAGE"*.

SECTION I.

OF THE ROOT.

THE *Radix*, or Root, is the lower part of the vegetable, which is generally attached to the earth, from which it derives various nutritious principles, which it

* See his Philosophia Botanica, &c. p. 37.

conveys to every part of the plant. It supports the *Herba* and the *Fructificatio.*

The root consists of two parts, which are denominated *Caudex** and *Radicula*†. By the term caudex, Linnæus means the stock, or main body of the root; and by the term radicula, the stringy or fibrous part of the root, which, in the greater number of vegetables, terminates the main root, and is supposed to be that part of the root which is especially concerned in absorbing nourishment from the earth.

In the language of Linnæus, the caudex is either descending or ascending. The *caudex descendens*, or descending caudex, strikes gradually downward into the ground, and puts forth radicles, or small fibres, which are generally regarded as the principal and really essential part of every root. The *caudex ascendens*, or ascending caudex, is that part of the root which gradually raises itself above the ground, serving frequently the place of a trunk or stem, and produces the herb. It is the descending caudex only which entirely corresponds to the term radix, or root, as it is employed by other botanists. The term caudex ascendens corresponds, in some measure, to the caudex of Malpighi, and other naturalists, who, following the authority of classical writers, designate by this name, the stem, trunk, or bole of a tree.

The distinction of Linnæus is, at least, ingenious. It is founded upon this fact, that trees and shrubs, when

* *Caudex*, from *cædo*, to cut down.

† *Radicula*, strictly speaking, a little root.

they are inverted, put forth leaves from the descending caudex, or proper root; and radicles, or roots, from the ascending caudex, or stem. Accordingly, the Swedish naturalist considers trees and shrubs "as roots above ground*."

In a philosophical analysis of the vegetable, this may, perhaps, be a just view of the subject: but it is not probable, that the distinction of the great naturalist will ever be generally admitted by the bulk of mankind; not even by those who are *somewhat* accustomed to speculate upon the nature of plants. We have so long been in the habit of regarding as the root, only that part of the vegetable which is buried under, or is immediately in connection with, the earth†, that it will be a difficult matter to bring ourselves to think, that the stem or bole of a tree can, with strict propriety, be considered as a part of its root.

The botanists have described various species of roots. I shall treat of the principal of them, under the following heads: viz. 1. of Roots, in respect to *form*, or *shape*: 2. of Roots, in respect to their *direction*, or *manner of growth*: 3. of Roots, in respect to their *duration:* and, lastly, I shall add some miscellaneous circumstances, concerning the *natural history of roots*, reserving, however, the completion of the subject for the second and third parts of these *Elements*.

* "*Arbores Fruticesque* omnes itaque sunt Radices supra terram. Ergo Arbor "verticaliter inverse, e caudice descendente, fert Folia, ex adsendente Radiculas." Philosophia Botanica, &c. p. 39.

† To this idea, however, there are exceptions, which I shall not omit to notice.

§. I.

Of Roots, in respect to their form, or shape.

Roots, with respect to their form or shape, may principally be referred to the following species, or perhaps more properly varieties: viz. 1. *Radix fibrosa*: 2. *Radix fusiformis*: 3. *Radix tuberosa*: 4. *Radix præmorsa*: 5. *Radix granulata*; and, 6. *Radix bulbosa*.

1. The radix fibrosa, or fibrous root, consists entirely, or principally, of a number of fibrous radicles, each of which is more slender than the base of the trunk or stem, to which it is attached. The greater number of the *Gramina*, or Grasses, such as the Wheat, the Rye, the Oat, the Barley, the Rice, &c. furnish us with the best examples of this form of root. In the grasses, the fibres proceed from a small knot at the base of the stem. This kind of root, consisting of very slender fibres, is sometimes denominated *Radix capillacea**; or the hairy root.

The term fibrous root comprehends a very great number of roots, which, as being more slender than the base of the stem or bole, may, with propriety, be arranged under this head. Such are the roots of the greater number of trees and shrubs.

2. The radix fusiformis, called in English fusiform or spindle-shaped root†, is a species of root, which ta-

* From *Capillus*, a hair.

† The fusiform-root is best known, in many parts of the United-States, by the name of "tap-root." There can, I believe, be little doubt, that the earlier settlers

pers from above downwards to a point, more or less slender. The radicles, strings, or fibres, are commonly disposed over the whole surface of the stock, or principal root. We have examples of this species of root in the Carrot, the Parsnip, the Hemlock, the Radish, Horse-radish, and many others. Cultivation frequently changes the spindle-shaped root into a round, knobbed, or tuberous root. This has been particularly observed in some of the umbelliferous plants.

3. The radix tuberosa, tuberous or knobbed root, is a hard, solid and fleshy root, which, in general, is thicker than the base of the stem to which it is attached. It consists either of one knob, as in the common Turnip, or of many such knobs collected, by means of a number of slender strings or filaments, into a bunch, as in the Pæony, Sun-flower, Drop-wort, Potatoe, and many others. The radicles, or fibrous strings, are dispersed over every part of the tuberous root; whereas in the bulbous roots, afterwards to be mentioned, the radicles are entirely confined to the bottom of the root.

Some of the tuberous roots, such as those of the Arum, Orchis, Moschatelline, and others, emit their radicles at the top, from a knot formed between the stem and the thicker part of the root. Such roots have been called *Radices comosæ**, from a fancied resemblance of the fibres, which I have mentioned, to a bunch of hair.

4. The radix præmorsa, for which there is no very appropriate English name, is a species of root, which

of the then British colonies introduced this word from England. It is, however, curious, and may not be improper to observe, that *tap-pee* is the name for the root of any vegetable in the language of several of our Indian tribes.

* From *Coma*, a bush or head of hair.

does not taper, but ends (abruptly) blunt, and thus appears as though it were bitten off short at the end. Hence, perhaps, it might, not improperly, be called the bitten root. The Scabiosa, or Scabious, the Plantago, or Plantain, the Valeriana, or Valerian, and some other plants, furnish us with examples of this form of root.

5. The radix granulata, or granulate root, consists of several little tubers, or fleshy knobs, which somewhat resemble grains of corn. The Saxifraga granulata, or White Saxifrage, of the English, exhibits one of the best examples of this kind of root.

6. The radix bulbosa, or bulbous root, is the last species of root which I have mentioned. This form of root, which Linnæus calls *Bulbus*, is, perhaps, more properly speaking, a large bud, situated under ground. It encloses and protects the future plant, several generations* of which lie enveloped in it, until they are unfolded by the action of water, or other fit alimentary stimulus. Linnæus calls this part, as he also does the true buds of trees and shrubs, the *Hybernaculum*, or winter-quarters of the plant. He does not consider the bulbus as a species of root. Many respectable botanists have implicitly adopted the Linnæan opinion on this head.

The bulbus consists of two parts, viz. the bulbus, properly so called, and the radicula, or radicle. This last is considered, by Linnæus, as a true root, or fibrous appendage, arising from the lower part of the bulb, by which it is attached to the earth, in which it grows.

* This subject will be particularly attended to in treating of the generation of vegetables. See Part II. At present, however, it may not be improper to observe, that in the bulb of the Hyacinth *four* distinct generations of future plants have been observed

These radicles may, it is thought, be considered as so many absorbing vessels, by which the various alimentary matters of the plant are conveyed, through the bulb, to every part of the stem, leaves, flowers, &c. Actual experiments, however, show, that the radicles, or cylindrical fibres, of certain bulbous-rooted plants, such as the Hyacinth, are by no means necessary to the full growth and perfection of these plants. This has been proved by the Marquis de S. Simon, in his work on *Hyacinths**. This writer considers the radicles rather as exhaling, than as absorbing organs; and asserts, that it is the middle part of the bulb which is endued with the absorbing power.

Four different kinds of bulbs are described by Linnæus: viz. 1. *Bulbus squamosus:* 2. *Bulbus solidus:* 3. *Bulbus tunicatus; and*, 4. *Bulbus articulatus.*

1. The bulbus squamosus, which in English we may call a squamose or scaly bulb, consists of a number of imbricated lamellae, thin plates, or scales, which are laid over each other, somewhat in the manner of tiles upon a house. Different species of Lilies furnish us with examples of this beautiful kind of bulb.

2. The bulbus solidus, or solid bulb, consists of one solid and fleshy substance. The Tulip is said, by Linnæus, and many of his followers, to supply us with an instance of this kind of bulb. I cannot, however, consider the bulb of the Tulip as a solid bulb. Carefully examined, it evidently appears to be a true coated bulb. Professor Ludwig has adduced the common Crocus, or

* Printed, at Amsterdam, in 1768. 4to

Saffron, as an example of the solid bulb. But even this, upon minute examination, appears to consist of a number of tunics, or coats, some of which (the exterior ones) spontaneously separate from one another; and the internal ones, though thicker, may, with ease, be separated. Indeed, some respectable writers have doubted, whether a true solid bulb, in the Linnæan sense of the word, does exist.

3. The bulbus tunicatus, the tunicated or coated bulb, consists of a number of tunics, or coats, which are regularly laid over each other. The common Onion, the Amaryllis, and many other plants, furnish instances of this species of bulb. The coats of this kind of bulb are sometimes very thick and succulent, insomuch that they are sufficient to make the plant vegetate, without the aid of earth or water. Thus, we often observe the officinal Squill, as it lies in the shops of the apothecaries, protruding both vigorous stems and flowers.

4. The bulbus articulatus, the articulated or jointed bulb, consists of lamellae, that are linked or chained togther, as in the Lathræa Squamaria, or Tooth-wort, the Adoxa Moschatellina, or Tuberous Moschatel, and the Martynia.

5. Linnæus also makes mention of a *Bulbus duplicatus*. This name is applied to certain roots, which have two bulbs connected together. Some species of *Orchides* furnish us with the best examples of this kind of root. Such is the Ophrys, which is called, in some parts of the United-States, by the ridiculous name of "Adam and Eve." Where two bulbs are thus united together, it is commonly observed, that one of them is light,

empty, and swims upon the surface of the water; whilst the other, which is solid, sinks by reason of its weight. From the former, the plant of the present year has proceeded, whilst the latter contains the bud of the future year*.

LINNÆUS, it has been observed, does not consider as a true root any of the species of bulb, which I have mentioned. He views them as large buds situated under ground, protecting the embryo from the severity of the winter, and from other injurious causes. That the bulb does, like a true bud, actually enclose the tender embryo, I shall not attempt to deny†. But I cannot convince myself, that this is a sufficient reason for asserting, that the bulb is not, in reality, a species of root. LINNÆUS IS NOT ALWAYS CONSISTENT. He has no hesitation in considering the tuber, or knob, of the Potatoe, as a true root: yet who does not know, that this tuber, as well as the bulbus, in the Linnæan sense of the word, encloses and protects the tender embryo? Linnæus informs us, that in the hollow stem of the Osmunda, near its root, is contained the embryo-plant, that is to be born the following year. Why does he not consider this "caulis cavus," or hollow stem, as a true hybernaculum, or bulb, or bud?

* For representations of different species of roots, see, in this work, particularly Plates II. and III. and also some of the individual plates illustrative of the sexual system of Linnæus.

† Yet I believe it would have been difficult for Linnæus to have *demonstrated* the pre-existence of the embryo, in all the different species of bulb. Who has seen the embryo, in some of the articulated bulbs? It must exist there, it will be answered, because the bulb shoots into a new plant, in every essential respect similar to the parent plant. Then the leaf of the Aloe, the leaf of the Orange, and the leaves of many other plants, are bulbs, or buds, for they, when committed to the ground, produce new plants, similar to their parents.

Besides, the observations of the Marquis de S. Simon, whom I have already mentioned, compel us to entertain doubts concerning some of the Linnæan notions respecting the bulb. The Swedish naturalist says, the radicles, or small fibres, which are attached to the bulb, are the only part entitled to the name of a true root. But it appears highly probable, that all these fibres do not act the part of absorbing organs, or vessels: some of them, at least, appear to be exhalents. Certain it is, that the radicles are not necessary to the nutriment of the plant, through the medium of the bulb. Some of the most vigorous blossoms are often protruded from bulbs, the radicles of which have fallen off, almost immediately after their appearance.

In the study of plants, it is a matter of essential importance to attend to the structure of the bulb, or bulbous root. These bulbs frequently afford excellent marks for distinguishing one species of plant from another of the same genus. Thus, the different species of the genus Scilla, or Squill, can hardly be distinguished from each other, except by the circumstance of their bulbs, which are coated, solid (at least, deemed solid), and scaly.

Here, under the head of the bulbous roots, it might not be improper to take notice of the *Bulbus caulinus*, or stem-bulb, and other similar productions, which, both in their structure and office, are very nearly allied to the bulb of which I have already treated. I shall, however, reserve the consideration of these stem-bulbs, &c. until I come to speak of the Hybernaculum, or winter-quarters of the plant.

Plants that are furnished with bulbs, or bulbous roots, have received the name of *Bulbosæ*, or Bulbous plants. These bulbosæ constitute one of the classes in the method of Andreas Cæsalpinus. *Bulbosæ* and *Bulbosis affines* are the names of the twenty-fourth and twenty-fifth classes in the *Methodus Propria* of Mr. Ray, the immortal English naturalist. Linnæus's ninth and tenth orders, *Spathaceæ*, and *Coronariæ*, in his attempt towards a natural method, embrace many of the finest vegetables that are furnished with bulbous roots. Such, among others, are the Hæmanthus, Amaryllis, Pancratium, Narcissus, Galanthus, Crinum, Colchicum, Allium, Polianthes, Ornithogalum, Scilla, Hyacinthus, Hypoxis, Lilium, and Tulipa.

§. II.

Of Roots, in respect to their direction, or manner of growth.

Roots, with respect to their direction, or manner of growth, are very different from one another.

1. Some roots are perpendicular, or run directly downwards into the earth. These constitute what Linnæus calls the *Radix perpendicularis*, or perpendicular root. This term is generally applied to a particular kind of root, which descends, in one straight fibre, that gradually tapers from above downwards, and whose greatest diameter does not exceed that of the base of the stem. The Carrot, Parsnip, and other spindle-shaped roots, as we have called them, are also examples of the perpendicular root. Some of the perpendicular roots

strike but a little way into the ground, such as the Datura, or Thorn-apple: some pierce deep, as the Horse-radish, the Phytolacca, or Poke, and others.

2. The *Radix horizontalis*, or horizontal root, extends itself under the surface of the ground, nearly in a horizontal direction. The Iris, the May-apple*, the Hop, the Cinquefoil, and many other plants furnish us with examples of this direction of the root. Some of the horizontal roots run very near to the surface of the earth; such as the Woodbine and the wild Anemone: others run lower down, as the Triticum repens, or Couch-grass. The horizontal root is sometimes called level or transverse-root. According to the greater or less severity of the climate, the perpendicular and horizontal roots (of the same species) will often be found to pierce the earth more or less remote from its surface. The root, as well as every other part of the plant, accommodates itself, in some measure, to the climate in which it grows.

3. The *Radix repens*, or creeping root, is, by Linnæus, distinguished from the horizontal root, to which, however, it is nearly allied. While the latter species of root is extended under the earth, in a transverse direction, the former is observed to creep horizontally, in every direction, putting forth fibres, as it proceeds. The Mentha, or Mint, furnishes us with an example of this kind of root.

4. The roots of some plants have a two-fold direction. Thus in the Primula, or Primrose, the stock, or main root, runs level, whilst the radicles, or fibres, strike perpendicularly downwards into the earth.

* Podophyllum peltatum.

5. Some roots are entire, that is not branched. These constitute what Linnæus denominates the *Radix simplex*, or simple root. Other roots are subdivided, or branched. These are the *Radix ramosa*, or branched root. The *Radix ramosissima* is a root which is greatly subdivided, or branches to a considerable degree.—The Podophyllum diphyllum, which I have called Jeffersonia binata, furnishes a good example of this last kind of root.

§. III.

Of Roots, in respect to their duration.

The period of the duration or existence of roots is very different. Some roots subsist for only one year; some for two, and some for many years. Those which subsist during only one year are denominated annuals: those which subsist for two years are called biennials, and those which subsist for many years are called perennials. It is only among the herbaceous* vegetables, that we have examples of annual and biennial roots. But the roots of both herbs and trees are perennials.

1. Annual plants, as I have already observed, exist only one year. At the completion of about this period, the root and the stem perish, and the individual dies, to rise no more from a root. It is perpetuated, however, by its seed.—Gleditsch has compared the annual plants with

* Herbaceous vegetables are those which have succulent stalks, or stems, that perish down to the root every year.

insects. The annual plant, as well as the insect, having undergone various metamorphoses, arrives at maturity, performs the office of generation; after which the male quickly perishes, the female surviving some time longer, to nourish and deposit the seed.

2. Biennial plants renew their stems only twice, after which the root perishes, the plant being perpetuated by its seed. Biennial are much less numerous than annual or perennial vegetables.

3. Perennial plants are such as subsist, by means of their roots or stems, for more than two years. Some of the vegetables of this class preserve both their roots and stems for many years; such are the numerous species of trees, the roots of which have been denominated *Radices fruticosæ**. The stems of other perennial plants perish to the ground, the stem being annually repaired out of the root.

Climate and cultivation exert a manifest effect upon the term of duration of the roots of vegetables. When transplanted into cold climates, many of the perennial plants become annuals, and the species is perpetuated by seed. Thus, in its native warm climate, the Ricinus communis, or Castor-oil plant, has a shrubby stem, and is a perennial; but in cold climates, both the root and the stem perish, and the vegetable is continued by its seed.

The effects of culture, in influencing the term of existence of the roots of vegetables, are much less under-

* *Radices fruticosæ*, or shrubby roots, from *Frutex*, a shrub.

stood, than the effects of climate. It is certain, however, that, in many instances, culture does prolong the life of annual plants.

§. IV.

Miscellaneous circumstances relative to the natural history of roots.

I. The roots of the greater number of vegetables are hid below the surface of the earth, and from its bosom they derive a large part of their nourishment and growth. But there are many vegetables which are not thus necessarily attached to the earth. The Misletoe, the Vanilla, the Dodder, the Hypocistis, and many others, do not emit their radicles into the soil, but migrate, if I may use the phrase, in search of nourishment elsewhere. They attach themselves to other plants, which they use as fulcres or props, and from which, it is highly probable, they derive *some* of their nourishment. Such plants are denominated *Plantæ Parasiticæ*, or *Parasitic Plants*. This term was, long ago, employed by the celebrated Malpighi. Linnæus makes much use of it, and he has not forgotten, in his employment of it, to glance severely at the close-clasping habits of some botanists, his contemporaries, and aspiring rivals after glory.

The Misletoe, the Vanilla, the Tillandsia, and many others, attach themselves to the branches of trees. The Asarum Hypocistis shows a preference to the roots of plants, particularly, it is said, the Cistus, or Rock-rose; whilst different species of Cuscuta, or Dodder, cling to the stems of a great variety of plants.

The parasitic plants attach themselves to other plants in various different ways. The seed of the Dodder having been deposited in the ground, there makes its first effort towards vegetation. It protrudes a stem, which seizes upon the first plant in its vicinity, to which it closely adheres. It is imagined that it derives its nourishment, by means of certain glandular organs, from the supporting plant. It is observed, however, that the lower part of the stem of the parasitic plant soon dries up, the root perishes, and the parasite lives upon its fulcre, or support. Perhaps, however, it is not certain, that it derives any essential part of its nourishment from the juices of the plant to which it attaches itself. It is highly probable, that, in many instances, parasitic plants injure their supporters, more by emitting from their bodies some noxious fluid, than by absorbing wholesome fluids from the supports*.

The Misletoe, the Vanilla, the Tillandsia, and the Hypocistis are never found upon the earth: they appear to have been originally produced upon the vegetables by which they are supported. The two first mentioned parasitic plants extend their roots under the bark, and even pierce the body of the wood. The Tillandsia usneoides, which is well known in North-America by the names of Long-Moss, and Spanish-Beard, is much more loosely attached to the trees of the forest. This parasite is so abundant in the southern parts of the United-States, and in New-Spain, that it even communicates a melancholy darkness to extensive woods.

* The Cuscuta Americana, or American Dodder, grows very abundantly in Pennsylvania, and other parts of the United-States. It clings to a great number of species of plants, and I am not certain, that it is found more frequently upon one species than upon another. This plant is known by two very different names, viz. Love-vine, and Devils-gutts.

2. The roots of many mosses attach themselves to the firm barks of trees, whilst the lichens cling to the hardest stones. Some species seem especially attached to stones of a calcareous nature; whilst others form a beautiful plating, as it were, upon the surface of whins, sand-stones, and never-dying granites. It has not yet been determined, with absolute certainty, from whence these latter mentioned vegetables derive their nutriment. It cannot be from the stony substances to which they are attached. It is probable, that they are nourished entirely by the atmosphere, and by water and other extraneous bodies which the atmosphere contains.

3. Some plants swim upon the water, and even perform pretty extensive migrations. Different species of Lemna*, or Duck-meat, swim upon the surface of the standing waters of Europe and North-America, and when not disturbed will cover the whole surface. Such plants cannot, with propriety, be said to be fixed to a certain spot. They are, indeed, furnished with radicles, or roots, but these hang loose in the water, from which, it is probable, they derive their principal nourishment. But the Fuci, or Sea-wreck, an extensive tribe of plants, perform migrations of hundreds of miles upon the ocean, where the eye of the navigator is often enlivened with extensive fields, which are principally composed of these vegetables.

4. Of the many thousand species of plants that are now known to the botanists, by far the greater number are, unquestionably, furnished with roots. Some plants, however, are said to be wholly destitute of roots. Such are the different species of the genus Tremella, which have

* Lemna gibba, L. minor, L. trisulca, and L. polyrhiza.

so many of the habitudes of animals, that, by certain writers, they have been considered as belonging more properly to the animal than to the vegetable kingdom.

5. According to Linnæus, the root is made up of *Medulla*, or Pith; *Lignum*, or Wood; *Liber*, or Inner Bark; and *Cortex*, or Outer Bark. These several parts will be more particularly mentioned, when I treat of the anatomy of vegetables*.

6. Linnæus, ever fond of analogies, compares the roots of plants to the absorbing lacteal vessels in animals. The earth he calls the stomach of plants†. The propriety of these terms will be attended to in the section on vegetable Digestion, in Part II. Meanwhile, the student ought not to be misled by the specious language of the illustrious Swede.

Section II.

OF THE HERB.

The Herba, or Herb, is the second general part of the plant which I have mentioned. By Linnæus, it is defined to be that part of the vegetable, which arises from the root, is terminated by the Fructification, and comprehends the Trunk, the Leaves, the Fulcres, and the Hybernacle.

* See Part II.

† "Plantarum Ventriculus est *Terra*, Vasa Chylifera *Radix*." Philosophia Botanica, &c. p. 93.

§ I.

THE *Truncus*, or Trunk, is the body, or main stem of the vegetable, whether it be a tree, a shrub, or an herbaceous plant. It supports the leaves and the fructification. Linnæus enumerates six species of trunk: these are, 1. the *Caulis*. 2. the *Culmus*. 3. the *Scapus*. 4. the *Pedunculus*. 5. the *Petiolus*, and 6. the *Frons*.

1. THE Caulis*, stem, or stalk, is the body of an herb or tree, supporting branches, leaves, and fructification. "To this description, says Dr. Milne, may be "added another circumstance, that caulis is an univer-"sal trunk; that is, proceeds immediately from the "root, whilst the foot-stalks of the flower and leaf, "which Linnæus likewise denominates trunks, are "partial; that is, proceed from an universal trunk, or "its branches." The caulis is the most common species of trunk, strictly so called.

THE stems or trunks of the grasses, the palms, the ferns, and the fungous plants, are distinguished by particular appellations, which will be noticed in their proper places.

I HAVE said, that the caulis is the stem or trunk of a vegetable, whether herb or tree. It is to be observed, however, that formerly the term caulis was applied to herbs only. The term truncus, which was employed to denote the stem, or trunk, or bole of a tree, is now em-

* Caulis, from the Greek καυλος. Dr. Martyn observes, that the "English "*Kale*, and *Cole* (in Colewort and Coleseed), come from *caulis*, as well as "*Cauliflower* vulgarly *Collyflower*: but immediately from the Low-Dutch *Kool*."

ployed as a generic name, of which the terms caulis, culmus, &c. are species.

THE caulis, or stem, is either simple or compound.

"SIMPLE stems are such as do not divide, but "proceed in a continued series towards their summits. "Compound stems are subdivided into *ramuli*, or small "branches, and diminish as they ascend, so as frequently "to lose the appearance of a stem altogether."

I. LINNÆUS enumerates the following species or varieties of the *caulis simplex*, or simple stem: viz. 1. *caulis nudus*, a naked stem, or a stem devoid of leaves and hair. 2. *caulis foliatus*, a leafy stem, or stem covered with leaves. 3. *caulis flexuosus*, a fluxuose stem, or stem which takes a different direction at every joint. 4. *caulis volubilis*, a twining stem, or stem which ascends, in a spiral direction, round the branch or stem of some other plant, or round some prop. 5. *caulis reclinatus*, a reclining stem, bending in an arch towards the earth. 6. *caulis procumbens*, a procumbent stem, lying along the ground, but not putting forth roots. 7. *caulis repens*, a creeping stem, or stem running along the ground, and striking root at certain distances. 8. *caulis sarmentosus*, or sarmentose stem; a slender stem, almost naked, or having only leaves in bunches, at the joints or knots, where it strikes root. 9. *caulis parasiticus*, or parasitical stem; a stem which does not grow immediately from the ground, but depends for its support upon some other vegetable. 10. *caulis teres*, a columnar stem, or stem without angles. 11. *caulis anceps*, or ancipital stem; a two-edged stem, compressed and forming two opposite angles. 12. *caulis triqueter*, or three-sided stem, having three plane or flat sides. 13. *caulis trian-*

gularis, or triangular stem, with three angles. 14. *caulis trigonus*, or three-cornered stem, having also three angles, with the sides concave or convex. 15. *caulis sulcatus*, or furrowed, grooved, or fluted stem; a stem marked, its whole length, with grooves, or channels. 16. *caulis striatus*, a striated or streaked stem; a stem marked, its whole length, with superficial or slight grooves, or channels. 17. *caulis glaber*, a smooth stem. 18. *caulis scaber*, a scabrous or rugged stem, something like shagreen. 19. *caulis villosus*, a villose stem; a stem covered with down or soft hairs: and 20. *caulis hispidus*, a hispid stem, covered with bristley-like arms, or minute prickles.

2. Of simple branching stems, Linnæus enumerates the following kinds, viz. 1. *caulis adscendens*, or ascending stem; a stem whose branches grow, at first, in a horizontal direction, and then gradually curve upwards. 2. *caulis diffusus*, or diffused stem; a stem furnished with spreading branches. 3. *caulis distichus**, a distich, or two-ranked stem; a stem with the branches horizontal, and produced in two rows: or, in other words, it is a stem whose branches proceed from only two sides of the stem. 4. *caulis brachiatus*†, or bracheate stem; a stem having branches, stretched out like arms, in pairs, and all nearly horizontal, each pair being at right angles with the next. 5. *caulis ramosissimus*, a stem very much branched: the branches disposed without any regular order. 6. *caulis fulcratus*‡, or fulcrated stem. This species of

* *Distichus*, from δις twice, and στιχος, a rank, or row.

† Brachiatus, from *Brachium*, the arm.

‡ *Fulcratus*, from *Fulcrum*, a prop.

stem is supported by the branches, which descend to the root; as in the Fig-tree, and the Rhizophora, or Sea-mangrove. 7. *caulis prolifer*, a proliferous stem, that puts forth branches only from the centre of the summit: as in the Pine, Fir, Cedar, &c. 8. *caulis simplicissimus*, the most simple stem, having very few branches, and proceeding in a straight line to the top, as in the Lathræa Squamaria.

3. Of the *caulis compositus*, or compound stem, the following species are mentioned by Linnæus, viz. 1. *caulis dichotomus**, a dichotomus stem, or stem which continually and regularly divides by pairs, from the top to the bottom. This is instanced in the Viscum, or Misletoe, the Valeriana Locusta, called Corn-sallad, the Chironia angularis, or American Centaury, and others. 2. *caulis subdivisus*, a stem divided into branches irregularly, or without order. 3. *caulis articulatus*, a jointed stem, having knots or joints situated at certain distances.

II. The Culmus, which may very properly be translated, Culm, but which is also called the Straw or Haulm†, is defined, by Linnæus, to be the proper trunk of the gramina, or grasses, elevating the leaves, the flower, and the fruit. "The word *Straw* being com-

* *Dichotomus* from δις, twice, and τεμνω, to cut: or from δικα and τεμνω, to divide by pairs.

† Haum, or Haume, is the older English spelling adopted from the Saxon. Thus, old Tusser uses the word:

"In champion countrie a pleasure they take
"To mow up their Haume for to brew and to bake:
"The haume is the straw of the wheat or the rye,
"Which once being reaped, they mow by and by."

"monly appropriated to the dry stalk of corn, I prefer "using the Latin culm*."

This species of stem is generally tubular, or hollow, and has very frequently knots or joints distributed, at certain intervals, through its whole length. Most of the grasses have a round and cylindrical stem, as in the Wheat, the Rye, the Oat, and many others. Some species of grasses, however, have a triangular culm. We have instances of this in several species of Schoenus, Scirpus, Cyperus, &c.

I have said, that the culm is very frequently interrupted by knots or joints; as in the Wheat, Indian-corn, or Maize,&c. This is the *culmus articulatus*, or jointed culm. But the culms of some species of grasses are entirely destitute of such knots. These are the *culmus enodis*, or knotless culm. The interval, or space, contained between every two joints of a jointed culm is called *Internodium*, and *Articulus culmi*. To avoid all ambiguity, it may not be improper to anglicize the Latin word internodium, by using the word Internode, as a learned veteran† in the science of Botany has done.

In the greater number of grasses, the culm is garnished with leaves, as in the Wheat, Rye, Indian-corn, &c. In some species, the culm is entirely naked, that is destitute of leaves. This is the case in certain species of Cyperus, or Cypress-grass. The culms of the greater number of the grasses of the temperate countries are entire, that is not branched. In the Indies, however, many of the grasses have branched culms. The culm sometimes consists of a number of scales, which lie over

* Professor Martyn. † Professor Martyn.

each other, in the manner of tiles upon a house. The culm of an Asiatic species of grass* is said to attain to the height of sixty or an hundred feet. Even within the limits of the United-States, one species† of Arundo, or Reed, whose stem is a culm, grows to the height of thirty feet.

Plants that are furnished with the particular species of stem which I have been speaking of, are known among botanists by the name of *Plantæ Culmiferæ*, or Culmiferous plants. By Linnæus they are denominated *Gramina*, or Grasses. Mr. Jussieu calls them *Gramineæ*. Of this very extensive and interesting family of vegetables, I shall take more particular notice, in a future part of this work.

3. The Scapus‡, or Scape, as Dr. Martyn translates the word, is a species of stem, or trunk, which supports the fructification, but not the leaves. The scape, like the caulis, is an universal stem, in which respect it differs from the pedunculus, or peduncle. The scape proceeds immediately from the root, whereas the peduncle proceeds always from the stem, or branches of the stem. The scape also differs from the *caulis aphyllus*, or leafless stem, because although the scape is naked, that is without leaves, it has, nevertheless, always radical or bottom leaves: but the naked stem is entirely destitute of leaves.—Dr. Milne observes, that in the *Species Plantarum* of Linnæus, "the term *Scapus* is generally "preceded by the superfluous word *naked*; an addition

* Panicum arborescens, a native of Ceylon.

† Arundo gigantea of Walter.

‡ Scapus, originally from σκηπτω, to lean upon; but more immediately from the classical Latin word, *Scapus*, the upright stem of an herb; the shaft of a column, &c.

" which is apt to mislead the unexperienced botanist, as " seeming to imply, that nakedness is not an essential " part in the description of this species of stalk."

After defining the scape to be a species of stem which supports the fructification, *but not the leaves*, it does, certainly, seem wholly unnecessary to inform us, that the scape is *leafless*. It must, however, be observed, that in some plants*, what is called the scape is not wholly leafless.

The following, among many other plants, furnish us with examples of the scape: viz. the Narcissus, the Pyrola, or Winter-green, the Convallaria majalis, or Lily of the valley, the Hyacinthus, or Hyacinth, the Dionæa Muscipula, the Sarracenia purpurea, the Hypoxis erecta, and the Sagittaria sagittifolia†.

4. The Frons, or Frond, is the sixth species of trunk enumerated by Linnæus. He defines it to be a kind of trunk or stem, which has the branch united with the leaf, and frequently with the fructification. In other words, it is a stem, " in which the leaves are confounded with the " stem and branches, and frequently with the flower and fruit." Linnæus restricts this species of stem to the Ferns and Palms, two vast families of plants, of which I am afterwards to make more particular mention.

Some respectable writers do not agree with Linnæus in considering the frond, as a species of trunk. It does not, indeed, appear in what very essential circumstance the frond does differ from a true compound leaf. Its two sides are very distinct from each other, in which respect,

* Tussilago alpina, &c.

† See, in this work, the figures of the four last mentioned plants.

it agrees with almost all known leaves: but differs from the other species of *real* stems, the two sides of which are no way different from each other. It must be observed, however, that the upper and under surfaces of the petiolus, and pedunculus, which the Swedish naturalist considers as species of trunk, are often, like the upper and under surfaces of the leaves, and frons, distinct, in their appearance, from one another. I think, upon the whole, that we should do no injury to the science of plants, were we to exclude, entirely, the frond from the list of stems.

5. The Stipes*, or Stipe, is the seventh and last species of trunk enumerated by Linnæus. He defines it to be the base of the frond, last mentioned, and he restricts it to the Ferns, Palms, and Fungous plants. The stem of the last-mentioned family of plants (comprehending the numerous species of mushrooms, &c.) is called by Dr. Withering, the Pillar.

The term stipes, or stipe, is also put by Linnæus, for the thread, or slender stem, or foot-stalk, which, in many of the compound flowers, belonging to the class of Syngenesia, elevates the feather-like or hairy crown (called *Pappus*), with which the seeds are furnished, and connects it with the seed. This appearance is sufficiently conspicuous in the common Lettuce, the Dandelion (Leontodon Taraxacum), the Colts-foot (Tussilago), and many other plants.

Of the Pedunculus and Petiolus (known among English botanists by the names of Peduncle and Petiole), I shall treat particularly under the head of *Fulcra*, or Fulcres.

* *Stipes*, originally from στιπος, a stake.

§. II.

The *Folium*, or Leaf, is the next part of the herba, that demands our attention.

It seems hardly necessary to attempt a definition of leaves: so familiar are these parts to the senses of all mankind. That it is not easy to succeed in our attempt after a definition of these parts, I infer from the very lame distinctions which have been given by celebrated writers. Thus, Linnæus defines the leaf to be "the organ of motion in a vegetable:" "Organum motus plantæ." But these words convey no manner of idea of the form or structure of the leaf. They only tell us, what the Swedish naturalist deemed to be the true use of leaves in the vegetable economy. Professor Ludwig defines leaves to be fibrous and cellular processes of the plant, which are of various figures, but generally extended into a plain membranaceous, or skinny substance*. Miller's definition of the leaf, might serve as a definition of almost every other part of the plant.

Reserving the consideration of some interesting particulars in the history of leaves, to the Second Part of this work, I shall now proceed to treat of leaves, under the following heads: viz. I. of leaves in regard to their *nomenclature:* II. of the *anatomical structure* of leaves: III. of the *uses* of leaves in the vegetable economy; and, IV. and lastly of certain *miscellaneous circumstances*, in the natural history of leaves.

* Ludwig, as quoted by Milne.

A. I. Of the Nomenclature of Leaves.

Leaves, considered in respect to their nomenclatural history, may be treated of under the three following heads, viz. 1. of *Simple Leaves:* 2. of *Compound Leaves:* and, 3. of *Leaves according to their Determination.*

1. The *Folium Simplex*, or Simple Leaf, is that species of leaf, which consists of only one, undivided portion, situated upon a petiole, or foot-stalk. In other words, the simple leaf is a leaf whose petiole is terminated by a single expansion, the divisions of which, however deep they may be, do not reach to the middle rib. "To understand this, let it be observed, that the "middle rib of every leaf is the principal prolongation "of the foot-stalk; which, to form the membranaceous "expansion, called the leaf, runs out—into a number of "ramifications, that inosculating and crossing each "other mutually, form the cortical net" of the leaf. "When these ramifications of the foot-stalk are so con-"nected, as to form one entire expansion, the leaf is "said to be simple; but when the middle rib becomes, "in fact, a foot-stalk, and many different expansions, "instead of one, proceed from the common foot-stalk, "the leaf is said to be compound." The middle rib of a leaf, whether it be simple, or compound, is denominated by Linnæus, costa. Of this more particular mention will be made, hereafter.

The forms of the simple leaf are almost innumerable. I shall here mention the greater number of those which are noticed by Linnæus, in his *Philosophia Bo-*

*tanica**. They are the following. viz. 1. *folium orbiculatum*, an orbicular, or circular leaf. 2. *folium subrotundum*, a leaf nearly round. 3. *folium ovatum*, an ovate, or egg-shaped leaf. 4. *folium ovale*, an oval leaf. 5. *folium parabolicum*, a parabolic leaf. 6. *folium spatulatum*, a spatulate, or spatula-shaped leaf. 7. *folium cuneiforme*, a cuneiform, or wedge-shaped leaf. 8. *folium oblongum*, an oblong leaf. 9. *folium lanceolatum*, a lanceolate leaf. 10. *folium lineare*, a linear leaf, as the leaves of the grasses. 11. *folium acerosum*, or acerose leaf; a leaf which is linear and permanent, as in the Pine, Yew, and many other evergreen trees. 12. *folium subulatum*, a subulate leaf; linear at the bottom, but gradually tapering towards the end. 13. *folium triangulare*, a triangular leaf. 14. *folium quadrangulare*, a quadrangular leaf. 15. *folium quinquangulare*, a five-cornered leaf. 16. *folium deltoides*, a deltoid leaf. 17. *folium rotundum*, a round leaf. 18. *folium reniforme*, a reniform or kidney-shaped leaf. 19. *folium cordatum*, a cordate or heart-shaped leaf. 20. *folium lunulatum*; shaped like a crescent. 21. *folium sagittatum*, a sagittate leaf; a leaf shaped like the head of an arrow†. 22. *folium hastatum*, a hastate leaf; a leaf resembling the head of a halbert. 23. *folium panduræforme*, a guitar-shaped leaf; as in Convolvulus panduratus, called Wild-Potatoe, &c. 24. *folium fissum*, a cleft-leaf; a leaf divided by linear sinuses, with straight margins. (According to the number of these divisions, the leaf is called, bifid, trifid, quadrifid,

* It is far, however, from being my intention to attempt any thing like a *full* definition or description of each kind of leaf. For the most satisfactory explanation of the Linnæan terms of leaves, &c. I must particularly refer the reader to Professor Martyn's work (*The Language of Botany, &c.*), which I so often mention in the course of these *Elements*, and which I always mention with pleasure.

† As in Sagittaria sagittifolia, of which see the figure in this work.

quinquefid, multifid, *bifidum*, *trifidum*, *quadrifidum*, *quinquefidum*, *multifidum*, *&c)*. 25. *folium lobatum*, a lobate or lobed leaf. 26. *folium palmatum*, a palmate or hand-shaped leaf. 27. *folium pinnatifidum*, a pinnatifid leaf. 28. *folium lyratrum*, a lyrate, or lyre-shaped leaf. 29. *folium laciniatum*, a laciniate, or jagged leaf. 30. *folium sinuatum*, a sinuate leaf. 31. *folium partitum*, or parted leaf; a leaf divided almost down to the base. (According to the number of the divisions, the parted leaf is called bipartite, or two-parted; tripartite, or three-parted, &c. &c. *bipartitum*, *tripartitum*, *quadripartitum*, *quinquepartitum*, *multipartitum)*. 32. *folium integrum*, an entire leaf. 33. *folium truncatum*, a truncate leaf; ending in a transverse line, so that it seems as if the tip of the leaf had been cut off: beautifully illustrated in the Liriodendron Tulipifera, or Tulip-tree, of North-America. 34. *folium præmorsum*, a leaf ending very obtusely, with unequal notches*. 35. *folium retusum*, a retuse leaf; ending in a blunt sinus. 36. *folium emarginatum*, a leaf notched at the end. 37. *folium obtusum*, an obtuse or blunt leaf. 38. *folium acutum*, an acute leaf, ending in an acute angle. 39. *folium acuminatum*, an acuminate or sharp-pointed leaf; ending in a subulate or awl-shaped point. 40. *folium cirrhosum*, a cirrose leaf; terminating in a tendril. 41. *folium spinosum*, a spiny or thorny leaf. 42. *folium dentatum*, a toothed leaf. 43. *folium serratum*, a serrate leaf, toothed like a saw. 44. *folium crenatum*, a crenate leaf; having the edge cut with angular or circular incisures, not inclining towards either extremity. 45. *folium repandum*, a repand leaf; having its rim terminated by angles, with

* See radix præmorsa, p. 7 & 8.

sinuses between them. 46. *folium cartilagineum*, a cartilaginous leaf. 47. *folium ciliatum**, a ciliate leaf; having the edge guarded by parallel bristles longitudinally. 48. *folium lacerum*, a lacerated leaf; with the edge variously cut, as if it were torn. 49. *folium erosum*, an erose or gnawed leaf; as if gnawed by insects. 50. *folium integerrimum*, absolutely entire; the margin or edge not in the least cut or notched. 51. *folium viscidum*, a viscid leaf; covered with a tenacious juice. 52. *folium tomentosum*, a tomentose, downy or cottony leaf. 53. *folium lanatum*, a woolly leaf; covered with a substance resembling a spider's web. 54. *folium pilosum*, a hairy leaf; having the surface covered with long, and distinct hairs. 55. *folium hispidum*, a hispid leaf (see *caulis hispidus*). 56. *folium scabrum*, a scabrous or rugged leaf (see *caulis scaber*). 57. *folium aculeatum*, a prickly leaf; armed with prickles. 58. *folium striatum*, a striated or streaked leaf. 59. *folium papillosum*, a papillose leaf; having the surface covered with fleshy dots. 60. *folium punctatum*, a dotted leaf. 61. *folium nitidum*, a glittering or glossy leaf. 62. *folium plicatum*, a plaited leaf; folded like a fan. 63. *folium undulatnm*, a waved leaf; with the surface rising and falling in waves, or obtusely. 64. *folium crispum*, a curled leaf. 65. *folium rugosum*, a wrinkled leaf. 66. *folium concavum*, a concave leaf; or leaf with the edge standing above the disk. 67. *folium venosum*, a veined leaf; a leaf whose vessels branch, or variously divide over the surface. (When a leaf has no perceptible vessels, it is called *folium avenium*, a veinless leaf). 68. *folium nervosum*, a nerved leaf; having vessels quite simple and unbranched, extending from

* From *Ciliæ*, the eye-lashes.

the base towards the apex, or tip. 69. *folium coloratum*, a coloured leaf; of any other colour than green. 70. *folium glabrum*, a smooth leaf. 71. *folium teres*, a columnar leaf; a leaf without angles. 72. *folium tubulosum*, a tubulous or hollow leaf, as in the Onion; and most singularly in the Sarracenia purpurea*. 73. *folium carnosum*, a fleshy leaf: full of pulp within, as in Sedum, and many other succulent leaves. 74. *folium compressum*, a compressed or flatted leaf. 75. *folium planum*, a plane or flat leaf; having the two surfaces parallel. 76. *folium gibbum*, a gibbous leaf; having both surfaces convex, owing to the abundance of pulp. 77. *folium convexum*, a convex leaf; with the edge more contracted than the disk. 78. *folium depressum*, a depressed leaf; hollow in the middle, having the disk more depressed than the sides. 79. *folium canaliculatum*, a channelled leaf; hollowed above with a deep longitudinal groove, convex underneath. 80. *folium ensiforme*, a sword-shaped leaf; tapering from the base towards the point. 81. *folium acinaciforme*, an acinaciform leaf; fleshy and compressed, resembling a sabre, faulchion or scymitar. 82. *folium dolabriforme*, a dolabriforme, axe, or hatchet shaped leaf. 83. *folium linguiforme*, a tongue-shaped leaf; "linear and fleshy, blunt at the end, convex underneath, and having usually a cartilaginous border." 84. *folium anceps*, an ancipital leaf; having two prominent longitudinal angles, with a convex disk. 85. *folium triquetrum*, a three-sided leaf (see *caulis triqueter*.) 86. *folium sulcatum*, a furrowed, grooved or fluted leaf (see *caulis sulcatus*.) 87. *folium carinatum*, a carinated leaf; having upon the back a longitudinal prominency, like the keel of a

* See Plate I.

vessel. 88. *folium membranaceum*, a membranaceous leaf; having no perceptible pulpy matter between the two surfaces.

II. "COMPOUND leaves are such whose footstalk is "terminated by several expansions; in other words, "whose divisions extend to the common footstalk, "which not running into the membranaceous part of "the leaf, supports the several lobes, or lesser leaves, "called *foliola*, of which the compound leaf consists."

THE foliola, or leaflets, as Dr. Martyn translates the word, are true simple leaves, the forms of which are, like those of the simple leaves already treated of, very numerous. These leaflets are sometimes furnished with particular footstalks; sometimes they are destitute of such footstalks, but are seated upon the middle rib of the compound leaf. The former leaflet is denominated *foliolum petiolatum*, a petioled leaflet; the latter *foliolum sessile*, a sessile leaflet.

IN the compound leaves, of which I am speaking, the central longitudinal fibre, or part to which the leaflets are attached, is denominated the costa, or rib. I have already observed, that the central fibre of the leaves, whether simple or compound, is known by the same name. This part of the leaf is by some writers denominated a nerve. This term ought not to be admitted in an accurate botanical language, since there is no reason to believe that any peculiar sensibility, the attribute of nervous matter, resides in the central fibre. It has also been called a vein. To this term there is less objection than to the former, since it is demonstrated, as I shall afterwards show, that a fluid circulates or moves through every part of the leaf,

along the course of the middle rib, and of the branches, which it sends out. Professor Ludwig has proposed to call by the name of nerve, the prominent division of the rib of the leaf; and by the name of vein, the pellucid part of the rib*. I think, however, that no manner of advantage is gained by this nice distinction.

Compound leaves are distinguished by Linnæus, into, 1. compound leaves, properly so called. 2. leaves twice compounded; and, 3. leaves that are more than twice compounded-

A. The *folium compositum*, or compound leaf properly so called, is a leaf only once compounded, and admits of the following species or varieties, which I shall mention in the order in which they occur in the *Philosophia Botanica*. 1. *folium articulatum*, a jointed leaf; when one leaflet grows from the top of another. 2. *folium digitatum*, a digitate leaf; when a simple or undivided footstalk connects several distinct leaflets at the end of it; as in different species of Æsculus, or Horsechesnut†. 3. *folium binatum*, a binate leaf; having a simple petiole connecting two leaflets at the top of it; as in Jeffersonia binata, &c. 4. *folium ternatum*, a ternate leaf; having three leaflets on one petiole; as in Trefoil, Strawberry, &c. 5. *folium quinatum*, a quinate leaf; having five leaflets on one petiole. (Linnæus considers the binate, the ternate and the quinate leaves as species of the digitate leaf). 6. *folium pinnatum*, a pinnate leaf; composed of a number of leaflets, arranged, like wings, along both sides of the middle rib. Of this beautiful

* Institutiones, &c. p. 26.

† See the plate of Æsculus spicata, in this work.

kind of leaf, we have many examples, but the finest occur in the leguminous plants, as they are called; as in different species of Robinia, Cassia, &c. &c. &c.*

To this general head of the pinnate leaf, Linnæus refers various species or varieties, such as 1. *folium pinnatum cum impari*; unequally pinnate, when the wings composed of leaflets are terminated by a single leaflet; as in Robinia viscosa. 2. *folium pinnatum cirrhosum*; cirrhosely pinnate; terminated by a tendril. 3. *folium pinnatum abruptum*; abruptly pinnate; neither terminated by a leaflet nor by a tendril. 4. *folium pinnatum opposite*; oppositely pinnate; having the leaflets placed opposite to each other, in pairs, as in Cassia marilandica. 5. *folium pinnatum alternatim*; alternately pinnate; the leaflets ranged alternately along the common petiole. 6. *folium pinnatum interrupte*; interruptedly pinnate; having smaller leaflets interposed between the principal ones. 7. *folium pinnatum articulate*; jointedly pinnate; when the common footstalk is articulated, or jointed. 8. *folium pinnatum decursive*; decursively pinnate; when the leaflets run into one another along the common petiole. 9. *folium conjugatum*, a conjugate leaf; having only one pair of leaflets.

B. The *folium compositum decompositum*, or decompound leaf, is so called, when the primary petiole is so divided that each part forms a compound leaf: in other words, the footstalk, instead of supporting small lobes, or leaflets, on the top, or on each side, bears partial footsalks, from which proceed the leaflets on both sides. To this head, Linnæus refers the following spe-

* See the plates of Robinia viscosa and Cassia marilandica.

cies of leaves, viz. 1. *folium bigeminatum*, or bigeminate leaf; having a dichotomous or forked petiole, with several leaflets at the extremity of each division. 2. *folium biternatum*, a biternate or doubly-ternate leaf; when the petiole has three ternate leaflets; as in Epimedium. 3. *folium bipinnatum*, a doubly-winged leaf, or frond; when the common petiole has on each side of it pinnate leaves*. 4. *folium pedatum*; a pedate leaf; when a bifid or forked petiole connects several leaflets on the inside only: as in Passiflora, Arum, Helleborus fœtidus, &c.

C. The *folium compositum supradecompositum*, or supradecompound leaf, is a species of compound leaf, in which the petiole, being several times divided, connects many leaflets, each part forming a decompound leaf: as in Pimpinella glauca, Ranunculus rutæfolius, &c. To this head Linnæus refers the following species, viz. 1. *folium triternatum*, a triternate or triply-threefold leaf; when the petiole has three biternate leaves. 2. *folium tripinnatum*, a tripinnate, or three times pinnate-leaf; when the petiole has bipinnate leaves ranged on each side of it; as in the Pteris aquilina, and other ferns. 3. *folium tergeminum*, a tergeminate or thrice-double leaf; "when a forked petiole is subdivided, having two "leaflets at the extremity of each subdivision; and also "two other leaflets at the division of the common "petiole†."

III. The Determination or Disposition of leaves, whether they be simple or compound, comprehends the following particulars, viz. *a*, the *locus*, or place of the

* As in Athamanta Libanotis, many Ferns, &c.

† Professor Martyn.

leaf. *b*, its *situs*, or situation, *c* its *insertio*, or insertion, and *d* its *directio*, or direction.

a. By the place of a leaf, botanists mean the particular part where it is attached to the plant. Under this head, Linnæus enumerates the following species of leaves, viz. 1. *folium seminale*, the seed-leaf; the primary leaves of the plant; being the cotyledons or lobes of a seed expanded, and in a vegetating state*. 2. *folium radicale*, a root-leaf; proceeding immediately from the root, and not adhering to the stem†. 3. *folium caulinum*, a cauline leaf; growing immediately on the stem, without the intervention of branches. 4. *folium rameum*, a branch-leaf; growing on, or proceeding from, a branch. 5. *folium axillare*, an axillary leaf; growing at the angle which is formed by the branch with the stem. 6. *folium florale*, a floral leaf; immediately attending the flower, and never appearing but with it. This last must not be confounded with the *bractea*, or bracte.

b. The situation of leaves respects their position in regard to themselves. Under this head, Linnæus enumerates the following species of leaves, viz. 1. *folia stellata*, or stellate leaves; when more leaves than two surround the stem in a whorl, "or radiate from the stem "like the spokes of a wheel;" exemplified in the Medeola verticillata, and Cucubalus stellatus‡. Such leaves are also called verticillate leaves. 2. *folia terna*, *quaterna*, *quina*, *sena*, &c. three-fold leaves, four-fold leaves, five-fold leaves, six-fold leaves: different species or varieties

* See Plate V.

† See the plates of Dionæa Muscipula and Hypoxis erecta.

‡ See the figures of these two vegetables.

of stellate leaves, when the leaves grow, in a whorl, three together, four, five, and six together. 3. *folia opposita*, opposite leaves; growing in pairs, each pair decussated, or crossing that above and below it*." 4. *folia alterna*, alternate leaves; coming out one after or above another, in a regular succession, or gradation; as in Ludvigia alternifolia†. The term alternate is opposed to the opposite. 5. *folia sparsa*, scattered leaves; neither opposite nor alternate, nor in any regular order: as in several species of Lily. 6. *folia conferta*, crowded or clustered leaves; leaves so copious as to occupy the whole of the branches, hardly having any naked space between: as in the Antirrhinum Linaria, called in Pennsylvania, Ranstedweed. 7. *folia imbricata*, imbricate leaves; lying over each other in the manner of tiles upon a house. 8. *folia fasciculata*, fascicled leaves; growing in bundles or bunches from the same point; as in the Larch-tree. 9. *folia disticha*, two ranked leaves; leaves respecting only two sides of the branch, though inserted on all parts of it: as in the Fir, and Lonicera Diervilla.

c. By the insertion of the leaves, is meant the manner in which they are attached to the plant. To this head, Linnæus refers the following species of leaves, viz. 1. *folium peltatum*, a peltate, or target-shaped leaf; having the footstalk inserted into the disk of the leaf, instead of the edge or base, which is the more common mode of insertion: as in different species of Nymphæa, such as the Nymphæa Nelumbo, Nymphæa odorata, &c. in the Tropæolum, or Indian-cress, which is mentioned in Part

* See the figures of Collinsonia canadensis, Veronica, Rhexia mariana, Gerardia flava, and other plants represented in this work.

† See the figure.

Second; in the Geranium peltatum, and the Podophyllum peltatum, or May-apple. 2. *folium petiolatum*, a petiolate or petioled leaf; growing on a petiole or footstalk, which is usually inserted into its base: as in the greater number of leaves. The term is opposed to sessile. 3. *folium sessile*, a sessile leaf; a leaf which is immediately connected with the stem or branch, without the intervention of a footstalk; as in Rhexia virginica*. 4. *folium decurrens*, a decurrent leaf; a sessile leaf, with its base extending downwards along the trunk, or stem: as in Symphytum, or Comfrey, Carduus, or Thistle, &c. 5. *folium amplexicaule*, a stem-clasping-leaf, embracing, clasping, or surrounding the stem by its base (N. B. some leaves go only half round the stem: these are denominated *folia semi-amplexicaulia*, or half-stem-clasping leaves). 6. *folium perfoliatum*, a perfoliate or perforated leaf; having the base of the leaf entirely surrounding the stem transversely; so that the stem appears to have been driven through the middle of the leaf: as in Bupleurum rotundifolium, Eupatorium perfoliatum, or Thorough-wort, &c. 7. *folium connatum*, a connate leaf; when two opposite leaves are so united at their bases as to appear as though they were one leaf: exemplified in the Garden Honeysuckle, &c. 8. *folium vaginans*, a sheathing leaf†; when a leaf invests the stem or branch by its base, in form of a tube: as in many Grasses, Polygonum, Rumex, &c.

d. With respect to their direction, leaves are as follows, viz. 1. *folium adversum*, an adverse leaf; when the upper side is turned to the south: as in Amomum. 2. *folium obliquum*, an oblique leaf, having the base di-

* See the figure. † "A glove-like leaf." Milne.

rected towards the sky, and the apex, or point, towards the horizon: as in Protea and Fritillaria. 3. *folium inflexum*, an inflex or inflected leaf; bent upwards, at the end, towards the stem. 4. *folium adpressum*, an appressed leaf; when the disk approaches so near to the stem, as to seem as if it was pressed to it by violence. 5. *folium erectum*, an erect or upright leaf; when it makes with the stem an angle so acute as to be close to it. 6. *folium patens*, a spreading leaf; forming an acute angle with the stem or branch upon which it is placed; between the erect and horizontal position. 7. *folium horizontale*, a horizontal leaf; making a right angle with the stem, the upper disk being turned towards the heavens. 8. *folium reclinatum*, a reclined leaf; bent downwards, so that the point of the leaf is lower than the base. 9. *folium revolutum*, a revolute leaf; having the edges rolled back, or towards the lower surface; as in Rosemary, Kalmia glauca, &c. 10. *folium dependens*; a leaf hanging down, or pointing directly to the ground. 11. *folium radicans*, a rooting leaf; a leaf shooting forth radicles, or roots; as in some aquatic plants. (This term is also applied to those leaves which being planted in the ground, there strike root and vegetate: such are the solid and fleshy leaves of several of the Liliaceous plants, the Aloe, Squill, &c. also the leaf of the Orange, and many other vegetables.) 12. *folium natans*, a floating leaf; a leaf which lies or floats upon the surface of the water; as in Nymphæa, Potamogeton, Trapa natans, &c. and 13, and, lastly, the *folium demersum*, or demerse leaf; called also a drowned or sunk leaf; a leaf which grows below the surface of the water: this is exemplified in Vallisneria spiralis and Vallisneria americana, especially the male plants; and in many other aquatic plants.—Some plants are constantly placed below the surface of

the water, whilst others withdraw themselves to the bottom of the water, in which they grow, in order to avoid the rigour of the winter-season.

In treating of the anatomical structure, and of the physiological functions of the leaves, I shall have particular occasion to observe, that between the upper and under surfaces of leaves there is a very essential difference. At present, it will be sufficient to remark, that, in the greater number of leaves, the nerves or veins, as they have been called, are much more in relief upon the under than upon the upper surface; and that, in general, the upper surface is of a deeper green than the under surfaee. The whole surface of a leaf is denominated by Linnæus, *Discus*, or the Disk. The upper surface is called *Discus supinus*; the under *Discus pronus*, the upper and under disk. *Pagina superior*, and *Pagina inferior* are also the names of the two disks, or surfaces. The *apex*, tip or end of the leaf, is the upper extremity, farthest removed from the base or insertion.

Ludwig and some other writers have distinguished leaves into primary and accessary. The primary leaves are those of which I have already treated: the accessary leaves are those which Linnæus denominates *stipulæ* and *bracteæ*, and of which I am to treat particularly under the head of Fulcres.

A knowledge of the leaves of plants is of the utmost importance in the study of Botany. In the investigation of the species of vegetables, there are no parts, which furnish us with such elegant characters or marks

as do the leaves. Nature seems to have taken delight in giving to the leaves, forms almost innumerable*. Without being acquainted with the principal and more determinate of these forms, it is impossible to make an extensive progress in the attainment of botanical knowledge. It is from the leaves, that some of the most eminent botanists, particularly Mr. Ray, Adrian Van Royen, and Linnæus, have taken the greater number of their specific names or characters of plants. The last-mentioned writer lays it down as an axiom, that the leaves exhibit the most elegant natural differences†. He allows, that good marks of distinction are afforded by the root, and the trunk, of which I have already treated, and also by the various other parts of the plant, of which, as yet, no particular notice has been taken.

As, however, the leaves of plants are subject to great variation, in respect to their forms and substance, and even in respect to their situation, so I cannot but think, that many botanists have laid too implicit a dependence upon their characters drawn from the leaves. Even Linnæus may, with strict propriety, be included in the list of these botanists. It is certain, that soil, climate, elevation above the level of the sea, and other circumstances, considerably vary the aspect of the leaves of vegetables. How different, in many instances, are the leaves of the same species of plant, when growing in a northern and more southern climate? How different the same species when confined to the valley or the plain;

* "Natura in nulla parte magis fuit polymorpha, quam in foliis, quorum "itaque species numerosissimæ, studiose a Tyronibus addiscendæ." Philosophia Botanica, &c. p. 218.

† "Folia elegantissimas naturalissimas differentias exhibent." Philosophia Botanica, &c. p. 218.

or elevated, far above the level of the sea, upon the sides or summits of lofty mountains? How different the same species when growing in a dry and in a wet situation?

Linnæus observes, that opposite and alternate leaves generally indicate very different plants, with the exception of such genera as contain some species that have opposite, and others alternate leaves*. But neither should too much dependence be placed upon this circumstance, in imposing specific names, or in drawing the characters of plants. Not unfrequently, the same individual has opposite leaves below, and alternate leaves above; or opposite above, and alternate below. This, indeed, is admitted by Linnæus, who gives a small list of plants, the exceptions to his general axiom†. But a much more extensive list might be given. I cannot, in this place, attempt to enter into the investigation of the subject. I may observe, however, that after a pretty extensive examination of plants, I am persuaded, that the leaves are much less constantly opposite or alternate, even in the *same* species, than many writers have imagined‡.

In the year 1751, the celebrated nosologist, Francis Boissier Sauvages, published his *Methodus foliorum seu plantæ floræ Monspeliensis juxta foliorum ordinem.* In this work, Sauvages has attempted an arrangement of plants, from the situation or position of their leaves. But no succeeding botanist, that I know, has implicitly adopted the method of the French writer. Nor is it probable, that a method founded upon such principles will

* Philosophia Botanica, &c. p. 102. † Ibid. p. 103.

‡ See the explanation of the figure of Ludvigia alternifolia.

ever be adopted by genuine botanists, in pursuit of determinate characters, or in search of nature's scheme. Innumerable natural families of plants, such as the Gerania, Saxifragæ, Ranunculi, Veronicæ, not to mention the treasures which the great continent of New-Holland is pouring upon us, forbid such an arrangement. An arrangement of vegetables founded upon the resemblances or differences of their leaves, will be even *much more* abominable, than the arrangements of those naturalists who have associated together quadrupeds, and other mammalia, from the affinities of their teeth and claws.

B. II. Of the Anatomical Structure of Leaves.

The anatomical structure of leaves is the subject which next claims our attention. It must be evident, however, that this is not the place to discuss this subject, in all its parts. I have not yet treated of the general anatomy of the plant; of the spiral and other vessels which enter into the composition of almost every part of the plant. I cannot, therefore, at present, attempt any thing further than a very superficial view of the structure of leaves. My attention will necessarily be again turned to this subject, in various parts of this work.

When the leaf of a plant is torn in a horizontal direction, we observe exteriorly a membrane, which is generally thin, and almost pellucid. This membrane has been called the epidermis, or scarf-skin, of the leaf. It has, with more propriety, been denominated the cortex, or bark of the leaf. This bark does not adhere to

the subjacent parts with equal firmness in all plants; nor, even on the two surfaces of the leaves, in the same plant. It possesses this singular property, that when you tear it off, it quickly folds itself inwards; but when it is dry, it is twisted in a contrary direction. This circumstance has induced some writers* to imagine, that the leaf contains two distinct systems of vessels. The pili, or hairs, which cover the surfaces of many leaves, appear to be seated in the bark. It is this part also, that is so frequently marked with white and other spots, in diseased plants. Sometimes, at least, as in the Cyclamen, or Sow-bread, the disease is not deeper situated than the bark: in some plants, however, it extends further, even into the parenchymatous portion of the leaf.

The bark of the leaf appears to be composed of an epidermis, properly so called, and a thicker substance, which, for distinction sake, might be denominated the cutis, or skin. It is the opinion of some physiologists, that this compound leaf-bark is a continuation of the outer and inner barks of the stem and branches, to which the leaf is attached: a supposition which seems extremely plausible, since the leaf appears to be, in fact, nothing but a kind of flat or compressed petiole, as is easily discovered by macerating a leaf and petiole in water. Now, the petiole can, in many plants, be shown to be composed of the outer and inner barks, the wood, and the medullary substance of the common trunk or stem.

The bark of the leaf is furnished with a number of glandular-like bodies, which are of different forms and

* Mr. De Saussure, at least.

sizes in different, and even in the same, species of vegetable. The late learned Mr. Horace Benedict De Saussure has endeavoured to show, in an express work* on the bark of the leaves and petals of plants, that these organs are real glands, which perform the office of animal glands; the secretion and the preparation of the juices of the leaf. It is known, that these cortical glands are found upon both disks or surfaces of the leaves of the herbaceous vegetables: but it has been asserted†, that in the arborescent vegetables they are exclusively confined to the under surface. This, when it is considered, that between trees or shrubs and the herbaceous vegetables, nature has not placed any decided distinction, seems not at all probable. But Mr. De Saussure has shown, that these glands exist upon the upper surface of the leaves of the Juniper.

The cortical glands adhere to the beautiful network of which I am presently to give an account, and are surrounded by a fibre, or small vessel. Between the gland and the vessel, there is, however, an interval. The shape of the gland is that of an oval oblong: the surrounding vessel is of an eliptical form. There is an evident communication between the vessels of the cortical net and this circumambient vessel. Mr. De Saussure also observed a small and slender vessel proceeding from the extremity of the gland, and communicating with the circumambient vessel of the gland. This beautiful structure of the bark of the leaf occasions us to regret, that hitherto, we have attained to so little certain knowledge concerning the real uses of the glandu-

* Observations sur l'ecorce des feuilles et petales. A Geneve: 1762.

† By Mr. Bonnet.

lar-like structure. Meanwhile, there seems to be little reason to doubt, that the glands are a necessary part of the vascular system, which is next to be mentioned.

UNDER the bark of the leaf, we meet with a beautiful net-work of vessels, which, whether they be arteries, veins, or absorbing lymphatics, are evidently a continuation of the vessels of the common stem, and petiole. This net-work is known by the name of the cortical net of the leaf. It is the *rete corticis* of Mr. De Saussure. It is composed of a great number of vessels, which, by crossing each other, and often anastamosing (for the language of the animal anatomists may, with strict propriety, be extended to vegetables), form the net-like appearance, of which I am speaking. The forms of the areas between the thread-like vessels composing the net are very different in different vegetables; and even in different parts of the same vegetable. These areas are more regular upon the upper than upon the under side of the leaf, and they are narrower and longer towards the petiole, or foot-stem of the leaf, than towards the middle and anterior part. Each area is commonly made up of six threads, so as sometimes to give to it an hexagonal form. More generally, however, the areas are formed by right lines.

THE fibres or threads of the cortical net are, unquestionably, vessels. They are transparent, and it is highly probable are a true system of absorbents, furnished with their proper glands. In the leaves of many plants, they are sufficiently distinct, without the aid of colouring injections: but they are seen to the greatest advantage, in many other plants, by immersing a common stem with a number of leaves, or a single leaf with

its petiole, in the diluted juice of the Phytolacca decandra: or in a solution of the sulphat of iron, and then transferring them to a decoction of galls. In the former case, the cortical net assumes a fine purple colour; in the latter it is as distinctly seen, being of a dark brown or ink colour.

In the leaves of the Maple, the cortical net is simple; in those of the Holly, it is double; and it appears to be triple in the leaves of the Orange*.

Under the cortical net, and in the areal interstices between the vascular fibres, we meet with another substance, which has received the name of the parenchyma, the pulp, or pith of the leaf. This substance is of a tender and cellular nature, but is by no means inorganic, or destitute of vessels. On the contrary, it appears to be distinctly composed of larger vessels than those which compose the cortical net; at the same time that the areal interstices are larger than those of the net. It is this pulpy substance which is so frequently consumed by the armies of insects, which spread their hateful ravages through the gardens, the fields, and the forests of our earth. Leaving entirely, or in a great measure, untouched, the net-like work which has been mentioned, we often observe the leaves of a tree reduced, by caterpillars, and various other species of insects, to the appearance of mere dead skeletons. It is by macerating, for a considerable time, in water, the leaves of plants, and thus reducing the parenchymatous part to a more tender pulp, and afterwards expressing it out, that we form those beautiful preparations of leaves, which are so well calculated to show the fabric of the cortical net.

* Professor Ludwig.

Such are the observations which I have to offer, in this part of my work, on the subject of the anatomical structure of leaves. I am sensible how imperfect I have left the subject. But the limits allotted to these *Elements*, do not permit me to dwell extensively upon any one of the various questions, which it is my duty to examine.

C. III. Of the Uses of the Leaves.

A subject more pleasing than any of those which I have hitherto touched upon, now presents itself to my view. I am to inquire into the uses of the leaves in the vegetable economy. This is a question of considerable difficulty. It has exercised the pens of some of the happiest talents, during the period of near two centuries. I exceedingly regret, that I shall be obliged to leave the subject involved in obscurity and doubt.

There is, I believe, no part or organ of the vegetable body, concerning the uses of which physiologists have been more divided in opinion, than respecting the leaves. It is not my intention, in the following concise view of the uses of these organs, to detail the opinion or hypothesis of every author on the subject. It is proper, however, that I should notice a few of the principal opinions, before I particularly attend to that one, which seems especially entitled to our examination.

The leaves have been considered as the perspiratory organs of the vegetable*. But Dr. Hales made an expe-

* J. S. Guettard, and many other writers

riment which renders it very improbable, that the leaves are *merely* perspiratory organs. This learned writer having cut off some branches of trees with apples upon them, and then stripped off the leaves, found that one apple perspired or exhaled about the same quantity of fluid as two of the leaves, the surfaces of which were nearly equal to the surface of the apple*. This simple experiment proved, that both the fruit, and the leaves perspired: it, certainly, gave no ground for asserting, that the leaves are exclusively the organs of perspiration.

By some writers, the leaves have been deemed the organs destined for the excretion of excrementitious juices. Dr. Hales, however, has shown, that in moist weather the leaves do not perspire at all. It has also been observed, that "as the vapour exhaled from vegeta-"bles has no taste," this idea is not more probable than that which considers the leaves as perspiratory organs†. This, to me, does not appear to be very satisfactory reasoning. Certainly, a fluid which, to our organs, has no perceptible taste, may be noxious to, and therefore proper to be thrown out of, the body of the vegetable. But the fluid perspired by the leaves of many vegetables is by no means entirely tasteless; and we well know, that it is often a fluid which exerts a very decided, and even powerful, effect upon our organs of smell. These circumstances do not, however, invalidate the opinion, that the leaves are pulmonary organs. On the contrary, they even give additional weight to that opinion.

* Statical Essays, &c. Vol. I. p. 30.

† Dr. Darwin.

Some writers* are of opinion, that the leaves absorb a large quantity of nutriment, which is conveyed to every part of the plant. As the leaves are so abundantly supplied with vessels, which appear to be absorbents; and as the leaves of many vegetables when entirely detached from the parent grow extremely well, we can hardly doubt, that they are, in some measure, the organs of nutrition to the plant.

Some ingenious philosophers have supposed, that the leaves acquire the electrical fluid from the atmosphere; whilst others, with perhaps as much propriety, have imagined, that these organs derive a certain phlogistic or inflammable principle from the light of the sun; because the leaves of so many vegetables are observed to present their upper disk or surface to the light. With respect to these two hypotheses, a very ingenious philosopher† has observed, first, "that no electricity is shewn "by experiments to descend through the stems of trees, "except in thunder-storms; and that if the final cause "of vegetable leaves had been to conduct electricity "from the air, they ought to have been gilded leaves "with metallic stems": secondly, "that if the final "cause of vegetable leaves had been to absorb light, "they ought to have been black and not green; as by "Dr. Franklin's experiment, who laid shreds of various "colours on snow in the sun-shine, the black sunk "much deeper than any other colour, and consequently absorbed much more light‡." We shall afterwards,

* Hales, Lars Kullin, Dr. Adam Hunter, Dr. Priestley, &c.

† Dr. Darwin.

‡ Phytologia, &c. Sect. IV.

however, have occasion to show, that light is essentially necessary to the just nourishment and complete health of the greater number of plants.

It has been supposed*, that the leaves are a kind of stomach or digestive organ to the plant; that the nutritious juices, which are absorbed by the roots, are conveyed to the leaves, where they undergo a more complete assimilation, which better befits them for the nutrition of the plant. But the function of vegetable digestion is by no means exclusively confined to the leaves; and it has not been proved, that these beautiful organs do, in fact, perform any very essential change in the obvious or intimate properties of the fluids or other matters, which are originally taken up by the roots. We are certain, that the leaves are incapable of essentially altering the taste, smell, colour and other properties of many of the bodies which their vessels absorb: and it would be rather unphilosophical to contend, that they are the digestive organs of the plant, unless we were able to prove (what has not yet been proved), that the nutritious matters which are conveyed from the root to the leaves, are again returned by the leaves to the stem, and other parts of the body.

More probable than any of the opinions, that I have mentioned, is that which ascribes to the leaves a kind of respiratory function. This opinion, which was early adopted by some of the ingenious philosophers to whom we are indebted for much of our knowledge of the physiology of vegetables, very naturally resulted from a few simple, but conclusive experiments. Mr. Papin

* By Gustavus Bonde, Professor Ludwig, Sir John Hill, &c.

found, that a plant which he had put into an exhausted receiver, lived a long time, provided only the *leaves* were permitted to receive the influence of the air. But when the *whole* plant was put into the receiver, without the precaution just mentioned, it died very soon. Hence, it was sufficiently evident, that the leaves absorbed or inspired air. Moreover, it had long been known, that the leaves of vegetables were destroyed by anointing their upper surface with oil. This seemed so analogous to the effect of oil in killing insects, to which it was applied, that it was naturally inferred, that the oil operated by stopping air-vessels in the leaves, as well as in the insects. About the year 1746, Lars Kullin, a Swedish writer, endeavoured to prove, that the leaves of trees absorb the external air, and that they afterwards exhale both air and water.

LINNÆUS has very expressly denominated the leaves, the lungs of vegetables*. I am not able, however, to discover, that the PRINCE of naturalists had advanced one step further, in the knowledge of the functions of the leaves, than many of his contemporaries, and even his predecessors. To the great loss of natural science, both Linnæus and Haller were taken from their labours in this world, soon after† the commencement of that brilliant era of the XVIII century, when PRIESTLEY, and other illustrious men, turned their attention to the relative relations which subsist between the atmosphere and vegetables. Had the Swede and the Swiss philosophers

* "*Folia* in motu constituta & perspirantia hoc modo pulmonibus respondent; in se tamen re ipsa musculi analoga sunt, licet non uti in animalibus cauda affixa, cum motus voluntarius in his dari nequeat." Philosophia Botanica. &c. p. 93.

† Haller died in 1777, and Linnæus on the eleventh of January, 1778.

lived a few years longer, they would, in all probability, have essentially changed some of their opinions, respecting the functions of plants and animals.

THE learned and ingenious Dr. Erasmus Darwin has taken much pains to prove, that the leaves are not only the lungs of vegetables, but that the office of these leaves is extremely similar to that of the lungs of man, and many other animals. The following is the substance of the author's arguments and speculations on the subject.

1. THE leaves "consist of an artery, which carries the "sap to the extreme surface of the upper side of the "leaf, and there exposes it under a thin moist pellicle "to the action of the air; and of veins, which there "collect and return it to the foot-stalk of the leaf, like "the pulmonary system of animals. 2. In this organ "the pellucid sap is changed to a coloured blood, like "the chyle in passing through the lungs of animals. "3. The leaves of aquatic plants are furnished with a "larger surface, and with points like the gills of aquatic "animals. 4. The upper sides of aerial leaves repel "moisture, like the larynx of animals. 5. Leaves are "killed by smearing them with oil, which in the same "manner destroys insects, by stopping their spiracula, "or the air-holes to their lungs. 6. Leaves have muscles "appropriated to turn them to the light, which is neces-"sary to their respiration—7. To this may be added an "experiment of Mr. Papin, related by M. Duhamel*. "He put an intire plant into the exhausted receiver of "an air-pump, and it soon perished; but on keeping the "whole plant in this vacuum, except the leaves, which

* La Physique des Arbres, &c. Premiere Partie. p. 169, 170.

" were exposed to the air, it continued to live a long " time, which he adds is a proof that the leaves are the " organs of respiration*."

I HAVE little hesitation in believing, that the leaves are somehow essentially concerned in the function of vegetable respiration. But I think it is far from being satisfactorily proved, that there exists in the leaf, a two-fold system of vessels, answering to the pulmonary artery and the veins of man, and other animals. I do not, however, deny, that such a system does exist in the structure of the leaf. I even think it probable that it does. I cannot, however, consider as decided the experiments which Dr. Darwin has adduced, in support of his opinion. I have made similar experiments with lactescent and other vegetable leaves, immersing them in colouring matters, such as the juice of the Phytolacca, or Poke, decoction of galls, solution of the sulphats of iron, and copper, &c. In making these experiments, it was easy to perceive, that a system of vessels, which runs between the bark and the wood of the stem, enters the petiole, its continuation the middle rib, and is finally beautifully spread upon the disks or surfaces of the leaf. But I have not been able to convince myself, that the colouring matter is exclusively diffused, in the first instance, upon the *upper* disk. In some of my plants, indeed, the colouring matter was most distinctly perceived upon the superior surface of the leaf, as in Dr. Darwin's experiments with Euphorbia helioscopia, Picris, and Senecio bicolor. In other plants, however, it was sufficiently evident, that the colouring matter, after passing through the petiole, moved more especially along the

* Phytologia, &c. Sect. IV.

lower side of the middle rib, and from this was carried through the vascular net of the leaf, nearer to the *lower* than to the upper surface of the leaf. These experiments were so frequently repeated (under a favourite impression too, that there is in plants, as well as in animals, a true circulation), that I cannot imagine, that I have been deceived in my observation.

It must be confessed, however, that the upper surface of the leaves of vegetables, does seem admirably adapted for exposing the vegetable blood to the action of the atmosphere; and IT IS HIGHLY PROBABLE, THAT FROM THE INFLUENCE AND ABSORPTION OF AIR, OR ONE OF THE COMPONENT PARTS OF THE ATMOSPHERIC MASS, THE JUICES OF THE LEAVES DO UNDERGO SOME VERY ESSENTIAL AND INDISPENSIBLE CHANGE. Perhaps, the blood of the leaf is oxygenated, or derives from the atmosphere, or from the water, in which it grows, a portion of vital air; much in the same manner that the blood of man and other land-animals is oxygenated by the vital air, which exerts its effects upon this fluid, through the medium of the lungs. The blood of man and many other animals does, unquestionably, derive its lively crimson color from the contact and absorption of vital air. It is even probable, that this vital air (so necessary to the maintainance of animal life) is the great source or foundation of the irritability of the system; since in the beautiful experiment of Charles Frederick Wolf, the attribute of irritability was first observed, in the incubated chick, at the very moment that the blood acquired its red colour*. Dr. Darwin, indeed, seems to have no doubts, that in

* Theoria Generationis. 1759. 4to.

the lactescent plants, with which he made his experiments, the milky fluid, after having been exposed to the atmosphere, upon the upper surface of the leaves, was evidently of a much whiter colour on the under surface. In the former case, as we have seen, he supposes the blood was carried, by an artery, from the petiole to the extremity of the leaf; and in the latter case, returned by a system of veins, corresponding to the pulmonary veins, from the extremity to the petiole. I have already, however, mentioned the experiments, which have compelled me to entertain some doubts as to the reality of a circulation in the leaves of plants. It is, certainly, too soon to speak decidedly on this subject. Many more experiments must be made, before the cautious philosopher will think himself excusable in implicitly admitting, or absolutely rejecting, the experiments of Darwin.

Whatever may be the precise function of the leaves in the vegetable economy, it is generally agreed among botanists, that a different office belongs to the upper and to the under sides of these organs. Thus, Dr. Darwin asserts, that it is the upper surface only, that respires. He justly remarks, that this surface, in many plants "strongly repels moisture," as in cabbage-leaves, where the particles of rain that lie over them, without touching them, have the appearance of globules of quicksilver. It appears, likewise, from actual experiments, that the leaves of many plants, when they were laid with their upper surfaces upon the water, withered almost as soon as in the dry air, though the same leaves, when they were placed with their under surfaces upon the water, continued green many days. These experiments, for which we are indebted to Mr. Bonnet, incontestibly proved, that with respect to the plants which

were the subjects of his experiments, there was an essential difference as to the absorbing capacity of the two surfaces of the leaves: the upper surface absorbing much less than the under surface.

Mr. Bonnet has also shown, by a number of well-conducted experiments, that the upper surface or disk of the leaves of many plants, exhaled much less than the under surface. He put the stalks of many leaves, fresh plucked, into glass tubes filled with water, having previously covered with oil or varnish the upper surfaces of some, and the under surfaces of others. Our ingenious philosopher uniformly observed, by the sinking of the water in the tubes, that the exhalation from the under surfaces, was more than double what it was from the upper surfaces. In a supplement to his great work*, on the uses of the leaves, Bonnet has further observed, that the inferior surface of the leaves of some aquatic plants is much better adapted for the purpose of absorption than the superior surface. He made his experiments with the leaves of a species of Nymphæa, or Water-Lily. It must not be forgotten, however, in this inquiry, that Saussure has discovered upon the upper surface of the leaves of some vegetables, a system of vessels, which appeared to that judicious author to be the same as the absorbing system of the lower surfaces of other leaves†. Upon the whole, there seems to be little reason to doubt, that both the upper and the under surfaces of the leaves of vegetables are furnished with their absorbing vessels; and it is highly probable, that, in many plants, air is ab-

* Recherches sur l'usage des feuilles dans les plantes, &c. A Gottingue & Leide: 1754. 4to.

† See page 48.

sorbed as well by the latter as by the former of these surfaces.

In concluding this subject of the uses of leaves, I must be permitted to observe, that some late philosophers have, in my opinion, too narrowly restricted the utility of the leaves to a single office. I cannot help thinking, that the office of the leaves, is a varied and a complex one. This, indeed, I have already intimated. Dr. Hales was of the same opinion, a long time ago. In his *Statical Essays*, a work which will be read and admired by a distant posterity, the amiable author does not hesitate to consider the leaves as the vegetable organs of nutrition, respiration, perspiration, and excretion. The experiments of Hales render it probable, that thus various are the functions of the leaves. I am persuaded, that future experiments will decidedly prove, that the leaves are not merely the lungs and perspiratory organs of the vegetable.

D. IV. Miscellaneous Circumstances relative to the Natural History of Leaves.

I. More than twenty-five thousand species of vegetables are now known to the botanists; and of this number a very large proportion is furnished with leaves. None of the trees, strictly so called, are destitute of these beautiful parts. Some vegetables, however, are leafless. Such are the two species of Ephedra*, or Shrubby Horse-tail, and the great family of Fungous plants. These last have many of the habitudes of animals, and

* Ephedra distachya, and Ephedra monostachya. The first species is a native of the south of France, and of Spain: the latter is a native of Siberia.

even the circumstance of their being leafless vegetables is one in the series of their relations to that vast empire of organized bodies.

2. The leaves of certain vegetables acquire a very great size. It is curious, too, to remark, that it is only in the hot or hottest portions of the globe, that we find the largest leaves. I believe that the cold climates, and even those which are moderately warm, do not furnish us with any instances of very large-leaved trees. It does seem, that the magnitude of the leaves of certain species of trees, increases as we approach the line*. In the cold climates, we find no Palms, with leaves so large as to be capable of sheltering whole families from the inclemency of the weather†. Why should we doubt (when a vast system of benevolence is so conspicuous in this earth), that in giving to the vegetables of hot climates such capacious leaves, the Author of the universe had consulted the health, the comforts, and the pleasures of the human inhabitants, destined to live beneath the scorching rays of the sun? But man is not the only animal that derives advantages from the large-spreading leaves of tropical trees. The birds and many other animals are equally benefitted. Destitute of this shelter, many species would be nearly incapable of subsisting in the countries in which they reside; and, in particular, they would be incapable (unless their instinctive operations were essentially varied) of rearing their young.

* The amiable Bernardin De Saint Pierre.

† One of the largest leaves that are known to us is that of the Talipot (Corypha umbraculifera?), a native of Ceylon. Robert Knox assures us, that a single leaf is capable of covering from fifteen to twenty persons. He considers the Talipot as one of the greatest blessings that Providence has bestowed upon the inhabitants of a country, which is parched by the sun, and inundated by the rains, for six months in the year.

3. The precise time of the year and month in which any given species of vegetable unfolds its first leaves is denominated, by Linnæus, *Frondescentia**. To this subject, the Swedish naturalist has paid much attention. He made a great number of observations, in eighteen different provinces of his native country, situated between the sixtieth and seventieth degree of north latitude, in the years 1750, 1751, and 1752. It was his object to discover, which species of trees begin to open their buds, and unfold their leaves, at the most proper time for the sowing of Barley. The result of his inquiries was, that the Birch-tree (Betula Alnus) gave the most proper indication for this purpose. He justly imagined, that in every province of Europe, there exist other trees, which will, in like manner, indicate the proper time for sowing grains of different kinds, and also esculent herbs. This is, certainly, a subject worthy of the attention of naturalists, whose inquiries are directed to utility. Much important information would result from an extensive investigation of the subject. The agricultural rules of savage nations are frequently founded, in a great measure, upon the frondescence, together with the time of flowering, of different vegetables, indigenous in their countries. Thus, the Indians, in different parts of North-America, are of opinion, that the best time for planting the Maize, or Indian-corn, is when the leaves of the White-Oak† first make their appearance; or rather, as they express it, when the leaves of this common tree are of the size of a ‡squirrel's ears. I shall have occa-

* From *Frons*, a leaf.

† Quercus alba..

‡ Sciurus cinereus, the most common species of Squirrel in North-America.

sion to touch again on this subject, when treating of the *Calendarium Floræ*, or Calender of *Flora**.

4. By the term *Defoliatio*†, or Defoliation, Linnæus means the season of the year at which the vegetables of any particular country shed their leaves. Thus, this term is directly opposed to that of frondescentia. With respect to the defoliation of vegetables, it is proper to observe, that the same species does not always drop its leaves at the same time, even in the same district of a country; but, in particular, that the same species sheds its leaves at very different periods, in different countries. In both instances, the difference of the time of defoliation seems to depend, principally, upon a difference of season, or of climate. Extreme heat and extreme cold are both observed to be favourable to the fall of the leaf. In the hot summers, the leaves of many plants lose their verdure, and fall a full month earlier than they do in milder seasons.

5. The fall of the leaf is almost always preceded by a very essential change in its colour. Yellow, red, and brown are the most common colours of the dying leaf. About the close of September (sooner or later according to the season), the forest-trees in Pennsylvania, and other middle parts of the United-States, begin to lose their verdure. The leaves assume new colours, particularly yellow and red, or crimson. Nothing can be more picturesque than an American forest, at this season. The beauties of the scenery will be described by some future

* See Part II.

† From *de*, and *Folium*, a leaf.

Thompson; or exhibited on canvass by the pencil of an American Salvator Rosa. It will be sufficient for me to observe, that the leaves of almost all the species of Juglans (Walnuts and Hickery) and Maple, assume different shades of yellow; whilst those of Nyssa integrifolia, called Gum, the Laurus Sassafras, the Cornus florida, or Dogwood, and others, are clothed in a livery of crimson, or red.

6. Some vegetables do not drop their leaves at all, during the whole year. Their verdure is not, in the least, injured by the changes of the weather. The Fir, the Juniper, the Yew, the Cypress, the Kalmiæ, and many others, belong to this class of Evergreens, as they are very emphatically called. In general, the leaves of the evergreens are harder and less succulent than those of deciduous vegetables. It is observable, also, that their surfaces are covered by a very thin, parchment-like cortex, or bark. It is found, that they perspire less than the leaves of deciduous vegetables. Some writers have, accordingly, conjectured, that the sempervirent quality of these vegetables is owing to the smallness of their perspiration. Dr. Arbuthnot imagined, that the verdurous quality was owing to the leaves containing more juices than can be exhaled by the sun. The celebrated Dr. Grew supposed, that a thick epidermis, dense cellular substance, and few tracheæ, or spiral-vessels, are the true cause of the perpetual verdure of these vegetables. Duhamel thought, that this state of the vegetable depended upon a hard knot, at the base of the leaves. Others, again, have supposed, that a gummy matter, residing within the vegetables, is the cause of the lasting verdure. But if this were the case, we should find, that Cherry-trees, Plumb-

trees, Peach-trees, and other vegetables that abound in gum, would be evergreens also. Perhaps, none of these explanations of the cause of the evergreen quality of leaves is wholly satisfactory. The circumstance seems principally referrible to climate. The same species is a perdifoil, or drops its leaves, in one climate, and preserves them in another. Thus, the Passion-flower* of America, and the Jasmine of Malabar†, are evergreens in their native climates, but become perdifoils when they are transplanted into Britain, and other northern parts of Europe. On the other hand, many of the perdifoils of cold climates, when transplanted to warmer climates, become evergreens. Thus, the Quince-tree is a perdifoil in northern countries, but becomes an evergreen when transplanted to the south of France, the island of Minorca, and other southern climates. I am assured, that the Currant-bushes which were sent from Britain, where they are deciduous, to the Island of St. Hellena, became, in a short time, evergreens, but ceased to bear fruit. Professor Thunberg informs us, that the Oak (Quercus Robur), the White Poplar (Populus alba), and other trees which were imported from Europe to the Cape of Good-Hope, "shed their leaves in the winter, as they do "in their native places, whereas the African trees "do not part with theirs. It is not long, however, "(continues our author), before they recover their "leaves again. This circumstance is singular enough: "first, because the cold here (at the Cape of Good-Hope) "in winter is not more severe than it is in Sweden in "the autumn; and in the second place, because they

* Passiflora coerulea.

† Jasminum grandiflorum.

" shed their leaves to the southward of the equator at " the very time that they put them forth to the north- " ward of it*."

7. Mr. Bruce informs us, that all the leaves of the trees in Abyssinia, are very highly varnished, and of a tough, leather-like texture, which enables them to support the constant and violent rains, under which these trees are produced†. This is a wise provision of nature. But in what, the highest or the lowest object, is not thy wisdom, Nature, conspicuous?

§. III.

I am now to speak of the *Fulcra*, the third general part of the herb mentioned by Linnæus.

The fulcra, or fulcres, are defined by the Swedish naturalist to be helps of the plant, for its more commodious sustentation, or support. Of these fulcres, Linnæus, at different times, enumerated a very different number. In the *Fundamenta Botanica*, published in 1736, they were six in number, and stood in the following order, viz. *Bractea*, *Cirrhus*, *Spina*, *Aculeus*, *Stipula*, and *Glandula*. In a subsequent edition of the same work, Linnæus enumerated nine fulcres, the three additional to those just mentioned, being the *Scapus*, the *Petiolus*, and the *Pedunculus*, which our author had formerly considered as species of trunks. In his immortal work, the *Philosophia Botanica*, published in 1750, we find but

* Travels in Europe, Africa, and Asia, &c. Vol. I. p. 104. English translation. London: 1796.

† Travels, &c. Appendix. p. 151, 152. Quarto edition.

seven species enumerated: viz. *Stipula*, *Bractea*, *Spina*, *Aculeus*, *Cirrhus*, *Glandula*, and *Pilus*. In the *Termini Botanici*, published in the *Amoenitates Academicæ**, by John Elmgren, one of the pupils of the great naturalist, and in the *Delineatio Plantæ*, which is prefixed to the second volume of the *Systema Naturæ*, the fulcres were to experience one more revolution. In these works, the terms *Aculeus* and *Spina* give way to the general term of *Arma;* and *Pilus* is supplanted by the less delicate, and less determinate, term *Pubes*, by which Linnæus means every species of pubescence, or hairy appearance, on the surface of plants. *Glandula* also is swallowed up in *Pubes*, and the partial trunks, *Petiolus* and *Pedunculus*, are again to appear among the fulcres. The list now stood as follows, viz. *Petiolus*, *Stipulæ*, *Cirrhus*, *Pubes*, *Arma*, *Bracteæ*, *Pedunculus*†.

I FIND it not a little difficult to satisfy my mind, as to the parts of the plant which ought to be introduced under this general head of fulcres. I do not think the science of Botany would loose much of its value, by

* Vol. VI. Dissertatio CXIII.

† Perhaps, no man of real celebrity in science was so much in the habit of making essential alterations, in the different editions of his works, as Linnæus was. Mr. Pennant, speaking of the Swedish naturalist's arrangement of the mammalia has, with delicate severity, used the following words: "The variations "in his different systems may have arisen from the new and continual discoveries "that are made in the animal kingdom; from his sincere intention of giving his "systems additional improvements; and perhaps from a failing (unknown, indeed, "to many of his accusers), a diffidence in the abilities he had exerted in his prior "performances. But it must be allowed, that the naturalist ran too great a hazard "in imitating his *present* guise; for in another year he might put on a new form, "and have left the complying philosopher amazed at the metamorphosis."

History of Quadrupeds. Preface.

the entire abolition of the term. Certain it is, that several of the articles enumerated by Linnæus cannot, with any degree of propriety, be considered as props, for the more commodious sustentation of the plant. Upon what principle, can we denominate the spina, the aculeus, the glandula, and the pilus, species of props? Perhaps, bractea and stipula have not a much higher claim to this title. But I dare not think of abolishing a term, sanctioned by the authority of so many able botanists; though one* of the most distinguished of them has confessed, that the term is rather "forced." I shall treat, under the head of fulcres, of the following parts of the plant: viz. 1. *Petiolus*. 2. *Pedunculus*. 3. *Cirrus*. 4. *Stipula*. 5. *Bractea*. 6. *Spina*. 7. *Aculeus*. 8. *Glandula*. 9. *Pilus*.

I. The Petiolus†, or Petiole, called also the Leaf-stalk, or Foot-stalk, is a fulcre supporting the leaf. I have had frequent occasion to make mention of this part, in the preceding pages. I have observed, that Linnæus, at different times, considered it as a species of trunk. But if the name fulcre must be retained, I think we may be glad to have an opportunity of referring to this head, both the petiole and peduncle. I am aware, that this is not the language of all botanists. Thus, Dr. Milne is of opinion, that neither the petiole nor the peduncle have been, with propriety, enumerated among the fulcres, "with which (says this often judicious writer) they "have no connection"‡.

* Dr. James Edward Smith.

† By the Roman writers, the term petiolus was employed to denote the foot-stalk of the fruit. In this sense, it is used by Columella.

‡ A Botanical Dictionary, &c. article Fulcra.

In the generality of plants, the petiole is nearly of the same colour as the leaf, to which it belongs. Indeed, it appears to be nothing but the leaf in a compressed state. The evolution of the leaf from the petiole is very distinctly observed in the Sallisburia adiantifolia, or Gingko*. The petiole of many plants is nearly cylindrical: it is, however, more commonly somewhat compressed, its upper surface, at least, being flatted; the under round or convex. "By this configuration, the "footstalks of compound leaves are generally, with ac- "curacy, distinguished from the young branches, with "which beginners are very apt to confound them†."

In the greater number of vegetables, the leaves and the fructification are supported by distinct footstalks. In a few plants, however, the same footstalk supports both the leaf and the flower, or the fruit. This is the case in Turnera ulmifolia, and in Hibiscus Moscheutos, or Syrian Mallow.

The petiole sometimes supplies us with very elegant marks for discriminating the different species of a genus. The *petiolus alatus*, or winged petiole, is a species of leaf-foot-stalk, which has a thin membrane or border, on each side of it. This little character distinguishes the Orange (Citrus Aurantium), from the Lemon (Citrus Medica). In the latter species, the petiole is linear, that is nearly of the same breadth its whole length. This is the *petiolus linearis* of Linnæus.

* The Maiden-hair-tree, a native of Japan.

† Milne.

2. The Pedunculus*, or Peduncle, is a partial stem, or trunk, which supports the fructification, without the leaves. I think it most proper to treat of it, in this place, among the number of fulcres. Professor Martyn properly calls it "the fulcre of the fructification."

Various species or varieties of the peduncle are enumerated by Linnæus. The principal of them are now to be mentioned.

a. With respect to its place of origin, a peduncle is, 1. *radicalis*, a root peduncle; proceeding immediately from the root. 2. *caulinus*, a stem peduncle; proceeding from the stem. 3. *rameus*, a branch peduncle; proceeding from a branch. 4. *petiolaris*, petiolary; proceeding from the petiole. 5. *cirrhiferus*, or tendril bearing. 6. *terminalis*, terminating, or proceeding from the top of the stem. 7. *axillaris*, axillary, proceeding from the axil, or angle, which is made by the leaf and the stem, or the branch and stem. 8. *oppositifolius*, opposite to a leaf. 9. *lateriflorus*, having the flower on the side of it. 10. *interfoliaceus*, among the leaves: perhaps, *intrafoliaceus*, within the leaf. 11. *extrafoliaceus*, without, or on the outside of the leaf. 12. *suprafoliaceus*; inserted into the stem, higher than the leaf, or than its petiole.

b. With respect to their situation, peduncles may be, 1. *oppositi*, opposite to each other, or, 2. *alterni*, alternate. 3. *sparsi*, scattered, without any regular order. 4. *verticillati*, in whorls.

* Mr. Ray, and other of the older botanists use *Pediculus*, instead of Pedunculus. The former is, certainly, the more classical name. It is sanctioned by Pliny, the naturalist, and other good writers.

c. With respect to their number, peduncles may be, 1. *solitarii*, solitary, or single. 2. *geminati*, double, two together, or in pairs.

In the umbellula, umbellule, or rundlet, of which particular mention is afterwards to be made, several equal peduncles proceed or diverge from the same centre, or point.

The peduncle, according to the number of flowers which it bears, is denominated, 1. *uniflorus*. 2. *biflorus*. 3. *triflorus*, &c. 4. *multiflorus*: that is, one, two, three-flowered, and many-flowered.

d. With respect to its direction, a peduncle may be, 1. *appressus*, pressed close to the stem. 2. *erectus*, upright. 3. *patens*, spreading. 4. *cernuus*, drooping, or pointing to the ground. 5. *resupinatus*, upside down. 6. *declinatus*, bowed, or curved downwards. 7. *nutans*, nodding, or curved downwards, more so than in the last mentioned, but less so than in the drooping peduncle. 8. *adscendens*, rising gradually. 9. *flaccidus*, weak or feeble, bending with the weight of the flower, which it supports. 10. *pendulus*, loose, tending downward with the leaf. 11. *strictus*, stiff and straight. 12. *flexuosus*, bending readily, in different directions. 13. *retrofractus*, bent backwards, as if broken.

e. With respect to its measure, a peduncle is, 1. *brevis*, short. 2. *brevissimus*, very short. 3. *longus*, long. 4. *longissimus*, very long.

f. With respect to its structure, a peduncle is, 1. *teres*, round, cylindrical, or perhaps rather columnar. 2.

triqueter, three-sided. 3. *tetragonus*, four-cornered. 4. *filiformis*, like a thread; or of the same thickness in all its parts. 5. *attenuatus*, tapering gradually towards the top. 6. *incrassatus*, growing gradually thicker towards the top. 7. *clavatus*, club-shaped; or thick at the end. 8. *nudus*, naked. 9. *squamosus*, scaly. 10. *foliatus*, leafy. 11. *bracteatus*, furnished with bracteæ, or bractes. 12. *geniculatus*, kneed, or bent at the joints; and, 13. *articulatus*, jointed.

3. The Cirrus*, or Tendril, called also Clasper, is a fine spiral string, or fibre, proceeding from different parts of the plant, and by means of which it fastens itself to some other plant or body. The term cirrus is synonimous to the terms Capreolus, Clavicula, and Viticulus of the older botanists.

Various species of tendrils are mentioned by Linnæus. These I shall notice under two heads: first, according to their place of origin, or situation: secondly, according to their form, or the number of leaves which they support.

I. To the first head, we refer the following: viz. 1. *cirrus axillaris*, when the tendril proceeds from the axil, or angle formed by a branch with the stem, or by a leaf with a branch. 2. *cirrus foliaris*, proceding from the leaf; as in the Pisum Ochrus, or Winged-Pea. 3. *cirrus*

* Linnæus writes the word Cirrhus, which is less proper, not sanctioned, as far as I know, by any good or classical writer. Martial, Phædrus, Pliny, &c. write it cirrus. The Latin word signifies a tuft, or lock of hair curled, a curl or frizzle, &c. The Greek original of the word is so doubtful, that I shall not notice the discordant opinions of authors on the subject.

petiolaris, proceeding from the petiole, or footstalk of the leaf. 4. *cirrus peduncularis*, from the peduncle.

2. To the second head belong the following, viz. 1. *cirrus simplex*, a simple or undivided tendril. 2. *cirrus trifidus*, a three-cleft tendril; a tendril divided into three parts. 3. *cirrus multifidus*, many-cleft, or often divided. 4. *cirrus diphyllus*, a two-leaved tendril; furnished with two leaves. 5. *cirrus tetraphyllus*, a four-leaved tendril; having four leaves. 6. *cirrus polyphyllus*, a many-leaved tendril; having many leaves. 7. *cirrus convolutus*, a convoluted tendril; twisted into rings, or spirals. 8. *cirrus revolutus*, a revolute tendril; when a spire of the screw having made half a revolution, turns back in a contrary direction*.

Tendrils are a very important appendage to many vegetables. The Solanum Dulcamara, Bignonia radicans, called Trumpet-flower, and some species of Hedera, or Ivy, emit tendrils, which serve the place of roots, planting themselves into the bark of trees, or in the walls of buildings. In the Cucumber, and other cucurbitaceous plants, the tendrils serve both for sustentation, and for shade. By means of these parts, the trunks of the plants are bound, as it were, together, and prevented from being at the sport of the winds. "The same claspers serve "likewise for shade: so that a natural arbour is formed "by the branches of the Cucumber, in the same man-"ner as an artificial one is made by tangling together "the twigs of trees; for the branches, by the linking of "their claspers, being couched together, the tender

* For a representation of the cirrus, or tendril, see the plate of Passiflora incarnata, in this work.

" fruits lie under the umbrage of a bower, made of their " own leaves*."

MANY of the papilionaceous or pea-blossom plants have twining tendrils, which wind to the right and back again.

MANY extensive families of plants are entirely destitute of tendrils.

PHILIPS has given a kind of instinctive perception to some of the tendril-vegetables, as appears from the following lines in his poem, entitled CYDER.

———" The Gourd,
" And thirsty Cucumber, when they perceive
" Th' approaching Olive, with resentment fly
" Her fatty fibres, and with Tendrils creep
" Diverse, detesting contact."—Book I. l. 257—261.

I SHALL afterwards† have occasion to observe, that it is among some of the vegetables that are furnished with tendrils, that we discover the most remarkable instances of that property, which has been called the perceptivity, or instinctive intelligence, of plants.

4. THE Stipula‡, or Stipule, is defined by Linnæus to be a scale, or small leaf, situated on each side of the base of the petiole and peduncle, or footstalks of the leaves and flowers, at their first appearance, and are designed for the purpose of sustentation, or support. Lin-

* Milne. † See Part II.

‡ Stipula, the diminutive of *Stipa*, tow; originally from στυπη, which also signifies tow.

næus's pupil, Elmgren, whose paper I have already referred to, restricts the term stipule to the petiole only.

The celebrated Malpighi, who may justly be stiled one of the fathers of vegetable physiology, was, I believe, the first person who gave to the public any observations concerning the number, the figure, and the situation of this part of the plant. Linnæus, borrowing the hint, has greatly improved upon the observations of the illustrious Italian naturalist. In particular, he has made much important use of the stipule in discriminating the different species of a genus, or family of plants.

Stipules are very conspicuous in the Tamarind, the Rose, the Cassia, the Melianthus, or Honey-flower, the Apricot, the Peach, the Bird-Cherry, the Magnolia, and many species of Pea-bloom flowers, &c. Perhaps, in no plant are they more beautifully conspicuous than in the Liriodendron, or Tulip-tree. In this and in some other vegetables, stipules may, with some propriety, be said to be fulcres, or supports. They enclose, protect, and cherish the young leaves, until they have acquired a larger growth, and greater strength. But, in many plants, the stipules appear to have nothing to do in the business of giving support.

In the greater number of plants, that are furnished with stipules, there are two of these scales or leaves, attached to the stem, one on each side of the footstalk. These are the *stipulæ geminæ*, or stipules in pairs. In the African Melianthus, and in the Ruscus, or Butcher's broom, there is only a single stipule, which in the first mentioned plant is placed on the inside, and in the latter

on the outside, of the stalk. Such stipules are called by Linnæus, *solitariæ*, solitary. In some plants, the stipules grow upon, or are inserted into, the sides. These are the *stipulæ laterales*, or lateral stipules. *Stipulæ extrafoliaceæ*, or extrafoliaceous stipules, are those which grow on the outside of the leaves, or below them; as in Betula, Tilia, and many of the Diadelphous, or Pea-bloom-flowers. This term is opposed to *stipulæ intrafoliaceæ*, or intrafoliaceous stipules; stipules that grow above, or within the leaves. *Stipulæ oppositifoliæ*, or oppositifolious stipules, are such as are placed opposite to the leaf.

In point of duration, some stipules fall off before the leaves. These are the, 1. *stipulæ caducæ*, or caducous stipules. We have examples of them in the common Cherry-tree, the Almond, the Poplar, the Elm, the Oak, the Beech, the Horn-Beam, the Birch, the Alder, the Fig, the Mulberry, and many others. Other stipules are deciduous: these Linnæus denominates, 2. *stipulæ deciduæ*, or deciduous stipules: they are those which fall off with the flower. 3. *stipulæ persistentes*, or permanent stipules, are those which continue until the fall of the leaves; as in the Rose, the Rasberry, the Cinquefoil, the Tormentil, the Avens, the Pea-bloom-flowers, and many others.

The terms sessile, adnate, decurrent, sheathing, subulate, lanceolate, sagittate, lunate, erect, spreading, reflex, very entire, serrate, ciliate, toothed, cleft, very short, middling short, long, &c. &c. are applied to stipules, as well as to leaves. For the explanation of these various terms, I must refer the reader to the terminology of leaves, in the preceding pages.

5. The Bractea*, Bracte, or Floral-leaf, is a leaf which, in general, differs from the true leaves both in shape and in colour, and is commonly situated on the peduncle, and often so near to the corolla as to be mistaken for the calyx. This is the case in Hellebore, Nigella, Bartsia, Peganum, and others.

The following, among other plants, furnish us with the most remarkable instances of the bracte, viz. the Tilia, or Lime-tree, Melampyrum, or Cow-wheat, Bartsia coccinea†, some species of Fumaria, or Fumitory, the Monarda didyma, or Oswego-tea, Polygala, or Milk-wort, Ononis, or Rest-harrow, Anthyllis, or Lady's finger, Glycine frutescens, or Carolina Kidney-bean-tree, &c. &c.

In general, the bracte is of the same duration as the common or true leaves of the plant. This circumstance is worthy of attention, as it will, in some instances, enable us to distinguish the bracte from the perianth, or flower-cup, which last almost always withers when the fruit has ripened, if not, indeed, before.

By not attending to this observation, the young or inexperienced botanist may very readily commit essential mistakes, in ascertaining the genera of certain plants;

* Bractea, in Latin, has the following significations, viz. a thin leaf, or plate of gold, silver, or any other metal; a tinsel, a spangle, a chip or thin piece of wood; a weather-cock upon the summit of steeples, turrets, &c. Hence it appears, that Linnæus has not discovered much taste in applying this name to the floral leaf. With respect to the English word, bracte, I should substitute in its place, floral-leaves, were it not that this term is frequently employed by Linnæus, to denote leaves which are situated near the flower, when they differ from the other leaves, though they are not, strictly speaking, bractes.

† See Plate IV.

such as Hellebore, Fennel-flower, Passion-flower, and others, which are furnished with bractes, but are destitute of calyx: at least according to the ideas of Linnæus respecting the calyx; for I shall afterwards have occasion to observe, that Jussieu, Adanson, and other eminent botanists, often give the name of calyx, to that part which Linnæus calls the corolla, or petals.

a. Bractes are either, 1. *virides*, green, or, 2. *coloratæ*, coloured. They are green in Hypoxis erecta, and beautifully coloured in Bartsia coccinea*.

b. In point of duration, they are either, 1. *deciduæ*, deciduous. 2. *caducæ*, caducous. 3. *persistentes*, permanent. These terms have already been explained.

c. In point of number, bractes are either, 1. *una*, one. 2. *duæ*, two. 3. *plures*, more than two. The following, among other plants, have, in general, but one bracte: viz. Chondrilla juncea, Aristolochia Pistolochia, and Erica Dabœcia. The following plants have two bractes: viz. Campanula alpina, Commelina Zanonia, Rosa canina, Royena villosa, Ruellia ringens, Cineraria sibirica, and Hypoxis erecta†. Erica calycina, and Atractylis cancellata have three bractes. Corymbium scabrum has four or five. Cunila pulegioides, Stipa spinifex, Bartsia coccinea, and many others, have several bractes.

d. In respect to size and height, bractes are, 1. shorter than the calyx, as in Justicia hyssopifolia, and Ruellia ringens. 2. longer than the calyx, as in Salvia

* See Plate IV.

† See Plate XIII. Fig. I. Hypoxis has often more than two bractes.

Sclarea, Ruellia repens, and Stipa spinifex. 3. larger than the calyx, and placed under it, as in Royena villosa. 4. shorter than the flower, as in Salvia sylvestris, Fumaria nobilis, and Minuartia campestris. 5. of equal length with the flower, in Fumaria bulbosa, Hypoxis erecta, Ornithogalum comosum; and, 6. longer than the flower, as in Ribes alpina, and Minuartia montana. 7. Cunila pulegioides, called, in the United-States, Penny-Royal, &c. besides a number of smaller bractes, has two that are larger than the flower, placed on each side of the footstalk.

e. In some plants, such as Crown-Imperial, Lavender, certain species of Sage, Bartsia coccinea, and a few others, the stem is terminated by a number of very large and conspicuous bractes, which are denominated *Coma**, and *Bracteæ comosæ*, from their resemblance to a bush or bunch of hair.

In discriminating the species of plants, bractes, particularly those of the bushy kind just mentioned, are of essential consequence.

The real use of the bracte, in the vegetable economy, does not appear to be completely ascertained. In many vegetables, indeed, this part is so very inconsiderable in size, and so similar to minute squamæ or scales, which, in other parts of the plant, have not seemed to merit any attention, and have not received a name, that it appears that such minute bractes are of no very indispensible consequence. But in other plants, the bracte is a part large, conspicuous, and seems to answer some im-

* *Coma*, from Κομη, a head of hair.

portant purpose. Dr. Darwin conjectures, that the bractes, or floral leaves, "supply an organ of respiration to "the calyx and pericarp of the flower-bud." All the different kinds of bractes, according to this multifarious genius, "serve the office of lungs, for the purpose of ex- "posing the vegetable blood to the influence of the air, "and of preparing it for the secretion, or production "and nourishment of the vegetable uterus, or pericarp, "and of the seeds produced and retained in it, frequent- "ly before their impregnation, and always after it."

Dr. Darwin observes, that in many plants, "brac- "tes do not appear till after the corol and nectaries, with "the anthers and stigmas, drop off; that is, not till after "the seed is impregnated, as in Colchicum autumnale, "Crocus, Hamamelis, and in some fruit-trees. The "production of the vegetable uterus, or pericarp, with "the unimpregnated seeds included in it, is (our author asserts) "in these plants accomplished or evolved, "like the bractes themselves, with the corol and sexu- "al organs, by the sap-juice, forced up in the umbili- "cal vessels from some previously prepared reservoir, "without the necessity of any exposition to the air in "leaves or lungs, which are not yet formed, though it "may acquire oxygenation in the fine arteries of the "embryon buds, which are supposed to surround the "horizontal air-vessels, observed in the bark of trees.

"As soon as the seeds become impregnated, the "corol and nectaries with the sexual organs fall off, and "the pericarp and its contained seeds are then nourish- "ed by the blood, which is aerated or oxygenated in "the bractes, or floral leaves. Thus the flower of the "Colchicum appears in autumn without any green

" leaves, and the pericarp with its impregnated seeds, " rises out of the ground, in the ensuing spring, on a stem " surrounded with bractes, and with other green leaves " below them, which produce new bulbs in their " bosoms."

Dr. Darwin is of opinion, that the blood which supplies nourishment to the pericarp and the seeds which it contains, " does not seem to require so much " oxygenation as that which supplies nutriment to the " embryon buds; whence (he remarks) the floral leaves " are, in general, much less than the root-leaves in " many plants, and than the common green leaves of al- " most all vegetables*."

6. The Spina, Spine, or Thorn, is a sharp process from the ligneous, or woody part of the plant, and is said to serve for its defence. We have instances of this in many plants, such as Prunus, Cratægus, Gleditsia, &c.

Spines are protruded from the stem and branches, as in Buck-thorn, Pear, Plum, and Orange trees; from the petioles, as in Robinia Pseud-Acacia, called Locust in the United-States; from the leaves themselves, as in Aloe; Agave americana, or American Aloe; Yucca filamentosa, or Adam's needle; Holly; Manchineel (Hippomane Mancinella), Butcher's-broom, &c. from the ribs of the leaves, as in several species of Nightshade: from the calyx, as in Thistle; from the seed-vessel, or pericarp, as in Datura Stramonium, or Thorn-apple, &c. &c.

Thorns are either terminating, that is placed at the end of a branch or leaf; or axillary, proceeding from the

* Phytologia, &c. Sect. IV.

angle which is formed by a branch or leaf with the stem. The first is the *spina terminalis*, and the last, the *spina axillaris*, of Linnæus.

Thorns are either simple, as in the greater number of thorny plants; double as in Horned Acacia; or triple, as in the Honey-locust of the United-States, which, on account of the number of its thorns, is called Gleditsia triacanthos. It must not, however, be supposed, that the number of thorns, growing together, in the same species, is always the same: for in the Gleditsia, although the number is, in general, three, there is sometimes only one; sometimes there are two, sometimes five or six.

7. The Aculeus*, or Prickle, is a sharp process from a plant, arising from the bark only, and not from the wood. In this respect, it differs essentially from the spina, or thorn, which is a prolongation of the woody part of the vegetable, to which it belongs. The difference of the origin of these two species of armature is very apparent, from the facility with which the prickle is detached, the bark merely coming away with it, and not the wood; whereas the thorn is not removed, without, at the same time, removing a portion of the wood. Owing to this difference of origin, prickles are less rigid than thorns.

The Rose, the Raspberry, the Berberry, the Aralia spinosa, called Angelica-tree; the Currant, and other bushes or vegetables, furnish us with familiar examples of the prickle.

* Aculeus, from *Acus*, a needle.

Prickles are either, 1. *recti*, straight; as in the Solanum indicum. 2. *incurvi*, bent inwards; as in Mimosa cineraria. 3. *recurvi*, recurved, or bent outwards. 4. *tomentosi*, downy; or covered with a silver-white wooly appearance; as in Solanum sanctum. 5. *acerosi*, chaffy; as in Solanum tomentosum. 6. *geminati*, double; or two growing together; as in Euphorbia canariensis, and in Euphorbia officinarum.

Prickles, when divided, are named, *furcæ*, forks, or forked prickles; and are called bifid, trifid, &c. from the number of their divisions.

We appear to be rather better acquainted with the final intention of nature in forming thorns and prickles, than some of the other parts of vegetables. These two species of armature seem to have been bestowed upon vegetables, in some measure, for the purposes of defence, against the injuries of animals. But that this is the *sole* use of the prickle and the thorn, many circumstances are calculated to render doubtful. Numerous vegetables, upon which various species of animals commit great ravages, are destitute both of spines and prickles; and, on the other hand, there are not a few instances of vegetables, which are carefully guarded with these armatures, although their poisonous or other quality is sufficient to secure them from injuries.

Culture exerts a decided effect upon both the spines and prickles of vegetables. The branches of the Pear, the Orange, the Citron, the Lemon, the Medlar, the Hawthorn, the Gooseberry-bush, not to mention others, when taken under the fostering care of the gar-

dener, often lose their spines. This shows how great are the effects of culture upon vegetables: perhaps, it even shows, that the spine and the prickle were intended for the purpose which has been mentioned; since vegetables so frequently lose their armature, when they are transferred to the soil that is tilled by man, who will guard, with interested attention, these plants from the depredations of animals.

8. The Glandula, Gland, or Glandule, is said to be a kind of secretory or excretory vessel, which is found upon the surface of many vegetables. In his *Philosophia Botanica*, Linnæus defines it to be a papilla excreting a fluid or humour*. In the *Delineatio Plantæ*, he defines it a fulcre secreting a liquor†. This last definition is unmeaning, and intolerable.

Glands are found upon almost every part of the surface of different plants. They assume a great variety of appearances. Sometimes, they resemble a blister or bladder, as in St. John's-wort; sometimes a number of scales, as in many Ferns; sometimes small grains, not unlike those of Millet, as in Fir-tree; sometimes a small cup, as in the Apricot-tree. In many instances, glands are furnished with their proper footstalks: often they are situated upon the leaves of plants, without any footstalks.

In the following plants, glands are situated on the petioles, or footstalks of the leaves, viz. Ricinus communis, Cassava, Passion-flower, different species of Cas-

* "Papilla humorem excernens."

† "Fulcrum secernens humorem."

sia*, and Robinia. They are seated on the indented or sawed edges of the leaves in the Willow-tree. In the Almond-tree, the Gourd, the Gelder-Rose, and the Bird-Cherry, they proceed from the base of the leaf. In the Urena, Tamarisk, Bastard Ricinus, and others, they spring from its back; whilst in the Butter-wort, and Sundew, they come out from its upper surface.

In some plants, as in Mountain Ebony†, and Apricot-tree, the glands are situated upon the tender stipules or scales, which surround the young foot-stalks of the flower and the leaves. Such glands are called by Linnæus, *glandulæ stipulares*, or stipular glands.

In other plants, as in the Currant-tree, Fig-wort, Viscous Campion, &c. &c. the glands are slender, like hairs: hence they are called *glandulæ capillares*, or capillary glands.

A glandular appearance is frequently observed between the stamens of certain plants, particularly those which belong to the xvth class, Tetradynamia, of the Sexual System‡.

Although Linnæus has been pleased to denominate the parts of which I have been speaking, glands, it is by no means certain, that they do, in reality, perform a glandular office. On the contrary, there are good reasons for suspecting, that many of the glandulæ, in the Linnæan sense of the word, are no ways concerned in the function of secretion.

* See the figures of Cassia marilandica, and Passiflora incarnata.

† Bauhinia aculeata.

‡ See Plate XIX. Fig. III.

These parts, whatever may be their uses, are of great importance in discriminating the species of certain genera of plants. Thus, the Almond and the Peach are two distinct species of one genus, the Amygdalus; but it is hardly possible to distinguish the two species, without calling in the aid of the glands. In the Almond, these are situated at the base of the leaves, upon the serratures; but the Peach is destitute of the glandular structure.

To this general head of glands, Linnæus seems to refer the following, viz. 1. *Folliculi*, follicles, or vessels distended with air, such as are observable at the roots of the Utricularia, or Water-Milfoil, and on the leaves of the Aldrovanda*. He might, with as much propriety, have added, the much larger bags, or vesicles, which are found upon various species of Fuci, or Sea-wreck. In these last, the air has been examined, and found to be much purer than atmospheric air. 2. *Utriculi*, or utricles, which are said to be filled with a secreted liquor; though, I believe, it cannot be proved, that it is, in *all* plants, a secreted liquor. The Nepenthes destillatoria, a native of Ceylon, furnishes us with a very remarkable example of what Linnæus calls the utriculus. The extremity of the leaf of this plant terminates in a filiform process, and this, again, in a cylinder, which is closed at the end by an opercle, or lid, so as to retain water. Different species of the genus Sarracenia have hollow leaves, which retain, for a considerable time, the water that has been received into them, from the rain, dew, &c†. But I cannot think, that

* Aldrovanda vesiculosa, a native of the marshes, or standing waters, of India and of Italy.

† See Plate I.

there is any manner of propriety in considering as glands, the curious structure of these two plants.

9. I AM now to give some account of the last species of fulcre enumerated by Linnæus. This is the Pilus, or Pubes. This is a general term, comprehending various species of pubescence, hairiness, or shagginess upon a plant; or, in other words, "whatever clothes it with any "hairy or villous substance."

THE following species of pubescence are enumerated by the Swedish naturalist: viz. *Pili*, Hairs. 2. *Lana*, Wool; or close curled hairs. 3. *Barba*, Beard; or parallel hairs. 4. *Tomentum*, Flocks; or interwoven villous hairs, scarcely conspicuous. 5. *Strigæ*, stiffish flattish hairs. 6. *Setæ*, Bristles; or stiffish roundish hairs. 7. *Hami*, Hooks; sharp crooked points. 8. *Glochides*, Barbs; straight toothed points, or pointed hairs.

I CANNOT pretend to enter into a full investigation of the history or appearances of all these various species or varieties of pubescence. The subject, however, is too important, in the study of plants, to be dismissed without some further notice.

PERHAPS, there are very few plants entirely destitute of some kind of hairy covering, or pubescence. It is true, indeed, that to the naked eye, the leaves or other parts of many vegetables appear to be absolutely smooth: but, even in these, the microscope discovers various little hairs, or other species of pubescence. It is especially upon the young stalks or stems of plants, that this minute covering is discoverable.

THE hairs which are distributed over the surface of vegetables assume a considerable variety of forms. Thus, in the leguminous plants, they are generally cylindrical: in the malvaceous plants, they terminate in a point: in the Agrimonia, or Agrimony, they are shaped like a fish-hook: in Nettle, they are subulate, or awl-shaped, and jointed; and in some of the Syngenesious plants, that are furnished with hollow, or funnel-shaped florets, they terminate in two crooked joints.

As early as the year 1682, the celebrated Dr. Nehemiah Grew, and in 1686 Marcellus Malpighi, had paid some attention to the different kinds of hairs which constitute a downy covering upon the surfaces of vegetables. But it was not until the year 1745, that the subject was handled in the masterly manner it deserved. In that year, Mr. J. Stephen Guettard, a very ingenious and learned French naturalist, began to publish his observations upon the hairs and glands of plants. These observations he continued during several succeeding years. The author has even established a botanical method deduced from the form, the situation, and other circumstances of the hairy and other glandular appearances, on the surface of plants. He has shown, what perhaps, would hardly have been suspected, that these appearances are, in general, constant and uniform in all the plants of the same family, or genus. Hence, he has observed, that they constitute good generic, but not specific, characters.

A MINUTE investigation of the subject of vegetable pubescence would be more worthy of our attention, if we were acquainted with the actual use of this kind of covering. But upon this subject, little certain can be said. It seems very probable, that the pubescence of

plants serves various useful purposes. I am inclined to think, that many of the hairs which cover the different parts of plants are exhaling and absorbing lymphatic-vessels. Some seem to have been designed, in a great measure, for the purpose of preserving the parts where they are lodged, from the effects of friction; whilst others may form a kind of covering, like the furs, hairs, bristles, &c. of animals, for protection from cold, and other injurious causes.

LINNÆUS asserts, that an experienced botanist will often find it easy to determine, from an inspection of plants, whether they belong to Africa, Asia, America, or the Alpine countries; though he may not be able to say, by what feature, in the general physiognomy, he has made the distinction. The Swedish naturalist, however, speaks of the American plants as being verdant, and smooth*. I do not doubt, that to the vegetables of extensive tracts of the three portions of the world which Linnæus has mentioned, a kind of national physiognomy often belongs: as we observe, that even the human inhabitants of such countries have a set of features exclusively belonging to them. Thus, an Anglo-American may, very generally, be distinguished from an Englishman. But I suspect, that there is much more difficulty than Linnæus seems to have imagined, in deciding, with certainty, from the mere *facies*, or aspect, of vegetables, upon the native countries of those vegetables. How, indeed, can this be doubted, when it is considered, that the very same

* "Primo intuitu distinguit sæpius exercitatus Botanicus plantas Africæ, "Asiæ, Americæ, Alpiumque, sed non facile diceret ipse, ex qua nota. Nescio, "quæ facies *torva, sicca, obscura* AFRIS; quæ *superba, exaltata* ASIATICIS; "quæ *læta, glabra* AMERICANIS; quæ *coarctata, indurata* ALPINIS? Philosophia Botanica, &c. p. 117, 118.

species of vegetables are common to two, and even three, quarters of the globe? Thus, the northern parts of North-America, and the northern parts of Europe, possess a considerable number of vegetables in common with each other. Many species are common to Siberia, Kamtchatka, Japan, &c. and to the north of America. A considerable number are common to the United-States and to Hindoostan; and even a few are common to the Cape of Good-Hope and North-America.

THAT the American plants are *peculiarly* smooth, I am far from being convinced. Linnæus might have found, in our woods, very many species covered over with all the various kinds of pubes, pubescentia, or pilus, which he has mentioned*. I cannot but suspect, that the great naturalist, misled by the phantom of a false analogy, conceived the plants of America very smooth, partly, at least, because the man of America has been so generally deemed, and by Linnæus†, among other writers, beardless, and smooth-skinned. But we now know, that the Indians of America are not more smooth than are the Japanese, the Chinese, the Koriaks, and many other nations or hordes of Asia‡.

* Such, not to mention many others, are Rhus typhinum, Epigæa repens, Spiræa tomentosa, Sida Abutilon, many of the Oaks, Walnuts, or Hickeries, and a very considerable number of species in the great class of Syngenesia.

† Systema Naturæ. Tom. I. p. 29.

‡ See New Views of the Origin of the Tribes and Nations of America. Preliminary Discourse. p. 55, and Appendix. p. 32.

§. IV.

" Where dwell my vegetative realms benumb'd,
" In Buds imprison'd, or in Bulbs intomb'd."

THE BOTANIC GARDEN. Part I.
Canto I. l. 459, 460.

I AM now to speak of that part of the vegetable which Linnæus has denominated the *Hybernaculum*, or Winter-quarters of the plant. Professor Martyn calls it the Hybernacle.

THE hybernaculum is defined by the Swedish naturalist to be a part of the plant which encloses the embryo-herb, protecting it from external injuries. In his language, it is either a *bulbus*, or a *gemma*.

I. OF the bulbus, or bulb, I have already made very particular mention*. I have given my reasons for considering it as a species of root. At present, I am to take no farther notice of it, but am to confine myself to the consideration of the Gemma, or bud. Previously, however, to my doing this, it will be proper to give some account of the *bulbus caulinus*, and other similar productions, to which I have alluded in a former part of the work†. Consistently with my view of the subject, I could not, with propriety, treat of those productions, under the head of roots.

THE bulbus caulinus, or stem-bulb, is a small species of bulb, or hybernacle, which is situated immedi-

* See page 8—13. † See page 12.

ately upon the stem or stalk of certain plants, having no immediate connection with the root. In the Dentaria*, or Tooth-wort, the Saxifraga, or Saxifrage†, the Lilium bulbiferum, or Bulbiferous Lily, and many other plants, we find small bulbs in the wings of the leaves, that is at the place where the leaf is united to the stem. If, after the stalks have decayed, these bulbs be taken off, and planted, they will soon take root, and vegetate. It is evident, therefore, that these productions are the repositories of an embryo or miniature-plant; and, therefore, they may, with strict propriety, be considered as a species of hybernacle.

In some of the alliaceous plants, or plants of the Onion and Garlick kind, bulbs, very similar to those which I have just mentioned, are produced at the origin of the umbel of flowers, between the peduncles, or footstalks of the flowers. Such alliaceous plants are frequently called bulbiferous plants. The individual bulbs are well known among gardeners, and in common language, by the name of "cloves‡."

The structure of these cauline and umbel-bulbs appears to be very similar to that of the true root-bulbs, of which I have given an account.

Bulbous granules, or productions, are very common in many species of Lichen, belonging to the xxivth class of the Sexual System. But, in these Lichens, the bulbs are situated without the axils of the leaves.

* Dentaria bulbifera.

† Saxifraga bulbifera, and S. cernua

‡ See Plate III.

In many plants, we observe an appearance, which, from its general affinity to that of the true bulbous granules, deserves to be mentioned, in this place. Some species of Poa, and other grasses, shoot out from their flowers, bulbous-like processes, which falling to the ground, there take root, and vegetate into plants similar to the parent*. Such plants are called viviparous plants. In the Tangekolli, a plant of Senegal, which is particularly mentioned by Mr. Adanson, the seeds germinate in the fruit or capsule, forming bulbs, or suckers, even before the fruit has arrived at maturity. The Agave vivipara, of East-Florida, exhibits a very similar appearance. After the flowers of this fine vegetable have fallen off, the seeds often vegetate, and even arrive to a pretty considerable size, their leaves being sometimes three or four inches long, whilst the new offspring is still attached to the parent tree. The branches of the Agave frequently appear alive with the young plants. These falling to the ground, there take root, and grow and flower. To this vegetable, a celebrated botanist, Paul Herman, gave the very appropriate name of *Sobolifera*†. The appearance exhibited by the Tangekolli and Agave, may, not unaptly, be compared to that of a Polypus, with a numerous progeny sprouting from various parts of her body.

Under this head of stem-bulbs, I may, with propriety, mention the fleshy and succulent leaves of various species of plants, particularly those of the liliaceous order, such as the Aloe, the Squill, and others; and also

* See Plate III.

† Aloe Americana Sobolifera.—Horti Academici Lugduno-Batavi Catalogus, &c. p. 16—18. pl. 2.

the leaves of some species of Arum, or Cuckow-Pint. These, if they be carefully planted in the ground, will, in due time, emit radicles, or fibres, and vegetate. Hence, it is evident, that there would be some propriety in denominating such leaves, hybernacles. Perhaps, the leaves of all plants contain the miniature-embryons of millions of plants, which are never brought into open view.

The bulbous granules, whether they be situated in the wings of the leaves, or other parts of the stalk, furnish the botanist with excellent marks for the discrimination of different species of plants, in the genera Ornithogalum, Dentaria, Polygonum, Saxifraga, Lilium, Allium, &c. Different species of these genera receive their specific names, *bulbifera*, or *bulbiferum*, and *vivipara*, or *viviparum*, from the bulbs which are found upon them*.

2. The hybernacle which more particularly claims our attention is the Gemma, or Bud. This is defined by Linnæus to be a species of hybernacle sitting upon the ascending caudex, or stem, and branches, and composed of stipules, or petioles, or the rudiments of leaves, or cortical scales. In fact, every bud is to be considered as an epitome, or compendium, of one or more plants similar to the parent plant. In other words, the bud, as Lofling observes, is nothing else than the plant or vegetable straitened from a defect of the powers of vegetation†.

* Dentaria bulbifera, Saxifraga bulbifera, Dioscorea bulbifera, Lilium bulbiferum, Polygonum viviparum.

† "Gemma enim nihil aliud est, nisi herba coarctata a defectu vis vegetantis," &c

The term hybernaculum, by which the naturalist of Sweden has designated the bulb and the bud, is very happily applied.

Mr. Ray is said to have been the first person who gave to the bud, of which I am speaking, the name of *gemma*. Before the time of that illustrious naturalist, one of the greatest ornaments of his country, the bud, we are told, had been denominated *germen*. It is admitted, indeed, that the term gemma was used before Ray's time, to signify a particular species of bud, viz. that which contains a flower; and some of the ancient authors appear to have carefully distinguished it from the germen, or bud, which contained leaves and wood. Pliny, whose merits are much greater than some writers will allow them to be, seems to mark the distinction between the gemma, and the germen, in very precise terms. The following are the words of the Roman naturalist: "Ger- "men autem est id, quod ex ipsis surculis arborum pri- "mo vere exit, ex quo deinde folium producitur: nam "gemma proprie est floris, quanquam utrumque con- "fundatur*."

Notwithstanding the very precise observation of Pliny, I think there are good reasons for supposing, that some of the purest of the Roman classical writers, used the term gemma, to express every kind of bud, without any regard to its individual contents. Thus, when Virgil, in the following lines, speaks of the buds of the Vine, under the name of "gemmæ," he, doubtless, means the leaf and flower-buds of that vegetable†:

* Naturalis Historiæ Lib.

† Ovid, too, as we shall afterwards see, calls the buds of the Vine, "gemmæ."

" Muscosi fontes, et somno mollior herba,
" Et quæ vos rarâ viridis tegit arbutus umbrâ,
" Solstitium pecori defendite: jam venit æstas
" Torrida: *jam læto turgent in Palmite gemmæ.*"

Eclog. VII. l. 45—48.

With respect to the word germen, although it appears, that this term was also used to denote a bud, it would seem, that it was more generally employed to denote a branch, or young twig, or sprout of a tree. In the following lines, Virgil, in describing the operation of vegetable inoculation, or budding, seems evidently to call by the name of "germen" the cion, or bud, which is made use of in this process:

" Nec modus inserere, atque oculos imponere, simplex:
" Nam quà se medio trudunt de cortice gemmæ,
" Et tenues rumpunt tunicas, angustus in ipso
" Fit nodo sinus: huc aliena ex arbore *germen*
" Includunt, udoque docent inolescere libro."

Georgic. Lib. 11. l. 73—77.

" Experienc'd art by varying culture knows
" To graft the cion, or the bud enclose.
" Where the swoln gem, in vernal vigour bold,
" Bursts through the bark, and breaks each yielding fold,
" Slit the mid knot, and, in the wound confin'd,
" Teach the strange bud to wed the bleeding rind."

Sotheby.

Buds assume different forms in different vegetables. In general, however, they may be said to be small and rounded, or conical, bodies, sometimes ending in a point. But the form of the bud is often so different in the different species of the same genus, as to afford to the botanist a good mark of distinction, in the winter-sea-

son, when the leaves and other parts, upon which the specific characters are more generally founded, cannot be seen. Thus, in many species of Willow, and in Rhamnus, or Buckthorn, the specific marks are often taken from the form of the buds.

In general, buds are placed at the extremity of the young and tender vegetable shoots, and along the course of the branches. They are fixed, by a short foot-stalk, upon a species of brackets, which are the remainder of the leaves, in the axils of which the buds of the present were formed the preceding year. Sometimes, we observe only one bud in a place: sometimes two are together, and these are either opposite or alternate: whilst, sometimes they are collected, in greater numbers, in whirls, or rings.

The construction of buds is at once beautiful and intricate. On the exterior surface of these vegetable cradles, we observe a number of scales, which are more or less hard, hollowed like a spoon, and laid over each other, in the manner of tiles upon the roof of a house. These scales are often beset with hairs, and other species of pubescence, and are fixed into the inner plates of the bark of the stem and branches, from which bark they seem to proceed. We cannot be at a loss to determine the use of these bud-scales. They serve to defend from cold, and other injuries, the tender and delicate embryon-plants, that are contained within the bud. The scales are often sealed, as it were, or connected to each other, and to the embryon within, by means of a thick, clammy juice, which in the buds of many vegetables, such as the Populus balsamifera, or Tacamahaca-tree, is of a resinous nature, and highly odoriferous.

It is probable, that in some plants, this viscous matter may be useful by preventing an excess of perspiration from the bud. When the internal parts of the bud have expanded and unfolded, the scales, being no longer useful, fall off.

The following observations of Ledermuller, an ingenious German naturalist, are well calculated to show the delicate and careful structure of the bud. In the winter-season, he separated from a Horse-Chesnut (Æsculus Hippocastanum), a bud not exceeding in size a common pea. He found the bud to be covered externally with seventeen scales, anointed with a viscid fluid. Having carefully separated these scales, the whole bud, covered with a lanugo, or down, was brought into view. On removing the down, he found the bud surrounded with four branch-leaves, and covering a spike of flowers. In this spike, our author very distinctly counted sixty-eight flowers! By the assistance of a microscope, even the pollen, or fecundating powder of the stamens, was observable. Some of it was opaque, and some transparent.

Three different species of buds are enumerated by the botanists. These are, 1. a bud containing a flower; 2. a bud containing a leaf or leaves; and 3. a bud containing both flowers and leaves.

I. The first species of bud that I have mentioned, is denominated *gemma florifera*, or the flower-bud. This contains the rudiments of one, or several, or many flowers, without leaves, folded over each other, and surrounded with scales. To this species of bud, the French have given the name of "bouton a fleur, ou au fruit."

It is often found at the extremity of the small branches of certain trees, which branches are shorter, more rough, and less beset with leaves, than the other branches. It is also observable, that this flower-bud is, in general, thicker, shorter, more square, and less pointed than the other kinds, which are next to be mentioned. It commonly terminates obtusely. This is the *gemma floralis* of Linnæus.

This species of bud is particularly mentioned by Pliny, who calls it *oculus gemma*. It is the bud which is employed in that species of grafting, which is called inoculation, or budding.

2. The second species of bud is the *gemma foliifera*, or leaf-bud. It contains the rudiments of several leaves, without flowers. This kind of bud is commonly more pointed than the first species. In some vegetables, however, as the Hazle-nut, it is nearly round; and in the Æsculus Hippocastanum, or Horse-Chesnut, it is very thick. Linnæus calls this species of bud, *gemma foliaris*.

3. The third species of bud is the *gemma foliifero-florifera*, or flower and leaf bud. This is the most common species of bud. In general, it is smaller than either of the two preceding buds, and produces, as the name imports, both flowers and leaves. Linnæus denominates this bud, *gemma communis*.

In this species of bud, however, the flowers, which are mixed with the leaves, are not always of the same kind. Sometimes, the bud protrudes, 1. male-flowers with leaves, as in the Pine, and Fir-tree: 2. female-flow-

ers and leaves, as in the Hazle-nut, and Carpinus, or Horn-beam. 3. hermaphrodite flowers, and leaves, as in the Elm-tree, Cornus, or Cornel-tree, Daphne, or Mezereon, and the Almond-tree.

THOSE buds which are evolved into leaves only, are called barren-buds. Those, which contain both leaves and flowers, are denominated fertile. These terms are very properly applied. It is observed, that from the size or bulk of the bud, we can often foretel, whether it contains merely leaves, or flowers and leaves together.

THE final object or ultimate end of the GREAT CREATOR OF THE UNIVERSE, in forming buds, must now, be sufficiently obvious. They are the protecting domes, the cradles, of tender embryons, which, in due time, are to burst from their enclosures, expose themselves to the light of the day, and spread eternal beauties over this earth.

" Vere nitent Terræ, vere remissus ager,
" Nunc Herbæ, rupta tellure, cacumina tollunt,
" Nunc tumido GEMMAS cortice palmes agit."

OVID. Fast. IV. l. 126.

SUCH being the use of the parts which I am considering, we are not to wonder, that the greater number of the trees and shrubs of cold climates are furnished with buds. In such climates, the protection which buds afford is wanted. Lofling has observed, that the Frangula, a species of Rhamnus, or Buck-thorn, is the only native tree of Sweden which is destitute of buds*. And

* See his excellent paper, entitled "Gemmae Arborum," in the Amoenitates Academicae. Vol. II. Dissertatio XXIV.

how beautifully does this vegetable demonstrate the office of the bud! The Frangula requires not the protecting aid of these winter-quarters: for "it grows under trees, in the marshy forests, where it is defended, along with other plants, from the severity of the winter*."

On the other hand, it ought not to excite our surprize, that buds are so seldom found upon the vegetables of warm climates: I mean those climates where an intensely cold winter is unknown. For in many countries, as in those of the northern and middle states of the American Union, although the summers are extremely warm, the winters are also intensely cold. In climates which enjoy an uniform series of mild or warm seasons, the tender shoots of vegetables do not stand in need of the protection of buds. The following list, from Lofling, will show what vegetables, among others, are destitute of buds: viz. Citron, Orange, Lemon, Cassava, Mock-Orange, Blad-Apple, Shrubby Swallow-wort, the Shrubby Geraniums†, Berry-bearing-Alder, Christ's Thorn, Syrian Mallow, Adansonia or Baobab, Justicia, Wild Senna, the Acacias and Mimosas, Coral-tree, Stinking Bean Trefoil, Oleander, Tamarisk, Heath, Barbadoes-Cherry, Tree-Mallow, the Shrubby Nightshades‡, Guinea Henweed, Cypress, Lignum Vitæ, and Savin.

* "Frangula est unica arbor indigena *Sueciæ*, quæ gemmis caret, sed habitat "illa sub arboribus, in nemoribus paludosis, cum alïs plantis a sevitia hyemis "defensa."

† Geranium fulgidum, G. inquinans, G. papilionaceum, G. betulinum, G. scabrum, G. cucullatum, G. gibbosum, G. carnosum, G. peltatum, G. acetosum, G. zonale, G. vitifolium, &c. &c. of Linnæus.

‡ Solanum verbascifolium, S. guineense, S. Pseudo-Capsicum, S. diphyllum, S. bonariense, S. pimpinellifolium, S. sanctum, S. tomentosum, S. bahamense, &c. of Linnæus.

Some of the vegetables, in this list, are large trees, such are the Adansonia, several of the Mimosas, &c. whilst others are smaller, but furnished with ligneous or woody stems, and belong to the families of shrubs and under-shrubs, as they are denominated by the English writers.

True or complete buds are never produced upon the annual plants, or those whose root and stem perish after the term of a year*. In these annual plants, however, small branches, like minute feathers, are protruded from the axils of the leaves. These feather-like processes, which seem to supply the place of the buds, wither without undergoing a more complete evolution or expansion, if the plants to which they belong are scandent, that is climb, and are destitute of lateral branches. But, in many other annual plants, these feather-like bodies, or small branches, grow into plants, similar to the parents.

In the trees of warm and hot countries, an appearance similar to that which I have described, is observed to obtain. In these trees, several of which are enumerated in the preceding list of budless vegetables, a plumula, or small feather, emits branches, without, however, any scaly covering: for, as I have already observed, this covering is not wanted, where there is no severity of climate to injure the tender shoot. The scaly covering essentially belongs to completely formed buds. "When "we, therefore, speak of trees having buds, that are "naked or without scales, our meaning is the same as "if we had said, that they have no buds at all†."

* See pages 15, 16.

† Milne.

Mr. Ray and Pontedera, have instituted a division of vegetables into herbs, or herbaceous vegetables, and trees, founding the distinction upon the absence or the presence of the gemmæ, or buds. The herbs they have distinguished by the name of plants wanting buds: the trees by that of vegetables bearing buds.

This division of the English and Italian naturalists, however, is certainly erroneous, and is calculated to introduce much confusion into the science of vegetables. It might not be improper, indeed, to adopt such a distinction in the history of the plants of one country, not very extensive, or not enjoying very different climates. But it ought not to be adopted in the history of the plants of the whole globe; since it plainly appears, that the greater number of the trees of warm climates are destitute of buds, or at least of that scaly appearance, which seems to belong essentially to buds; and, hence, such trees, some of which are very large and stately, ought, upon the principles of the two authors whom I have mentioned, to be thrown into the same class or series as the humble, herbaceous plants. Father Plumier discovered much judgment in associating together the trees and the herbaceous plants; though his illustrious countryman, Tournefort, had kept them asunder.

With respect to the origin of buds, two different opinions have been entertained by botanists. Pontedera a very learned Italian botanist, imagined, that the buds derive their origin from the ligneous, or woody fibrillae. This opinion has not, so far as I know, been adopted by any succeeding naturalist.

It is much more probable, that the buds derive their origin from the medulla, or pith of the vegetable. It is certain, that the pith is essentially necessary to the existence and growth of the buds. But this subject will come more naturally to be treated of, when examining the anatomical structure of vegetables*.

As every vegetable-bud contains the *primordium*, or embryon of a plant, and if separated from its parent, and nurtured with care, would produce a plant specifically the same as the supporting stock, we are led to reflect upon the unbounded fertility of Nature, who seems to have taken delight in forming (I would say to the extent of her power, if to the power of Nature there were any limits), living, organized existences. Linnæus has made a calculation, by which it appears, that ten thousand buds, or, in other words, ten thousand herbs, may be produced from a single trunk, not exceeding a span in diameter. What an infinity of plants, then, might be raised from some of the most stupendous trees, such as the Adansonia of Africa, or the Liriodendron, Platanus, and others of North-America! But the fertility of nature, in the formation of buds, is infinitely greater than even philosophers themselves have, in general, imagined. MILLIONS OF BUDS LIE LATENT IN THE TREE, AND NEVER MEET THE LIGHT OF THE DAY. The embryon punctum is not evolved into notice, from a deficiency of those stimulating agents, which, if they be not the sole cause of life, are, at least, essentially necessary to bring the phenomena of life into view.

In treating of the seed, I shall hint at the comparative fertility of the vegetable and animal kingdoms.

* See Part II.

Section III.

OF THE FRUCTIFICATION.

We now enter upon the consideration of the third great general division of the vegetable, which is named the Fructificatio*, or Fructification. This is beautifully defined by Linnæus, to be a "temporary "part of vegetables, dedicated to the business of gene-"ration, terminating the existence of the old, and beginning the era of the new, vegetable†."

The essence of the fructification consists in the flower and the fruit. These two parts, according to the Sexualists (or those who admit of the existence of two distinct sexes in vegetables), are connected in the same manner, as generation and birth are connected together in animals. For although the fruit does not swell and come to perfection, until after the flower has decayed, or fallen, it seems to be sufficiently established as a fact, by the experiments of many learned men, that the *primordia*, or earliest rudiments, of the fruit, pre-exist in the flower. But this subject will be particularly attended to, in a future part of this work.

When perfect, the fructification consists of the following seven parts: viz. 1. the *Calyx*. 2. the *Corolla*. 3. the *Stamen*. 4. the *Pistillum*. 5. the *Pericarpium*. 6. the *Semen*. 7. the *Receptaculum*. Of these, the four

* Fructificatio, from *Fructus*, fruit, and *facio*, to make.

† "Fructificatio Vegetabilium pars temporaria, Generationi dicata, antiquum terminans, novum incipiens." Philosophia Botanica, &c. p. 52.

first belong to the flower, properly so called; the two next to the fruit, and the last is common to both.

§. I.

I BEGIN with the Calyx*. This is defined by Linnæus the "outer bark of the plant, present in the fructification." The calyx is frequently denominated, by English writers on botany, the empalement and flower-cup. It seems more proper, however, to adopt the Latin word; since the word flower-cup, if used, ought certainly to be restricted entirely to one particular species of calyx, the perianthium, or perianth; whereas the term calyx is a generic phrase, comprehending, as we shall presently see, various parts, very distinct in their appearances, and perhaps, in their office.

LINNÆUS enumerates seven different kinds of calyx: viz. 1. the *Perianthium*. 2. the *Involucrum*. 3. the *Amentum*. 4. the *Spatha*. 5. the *Gluma*. 6. the *Calyptra:* and 7. the *Volva*.

1. THE Perianthium†, or Perianth, is the most common species of calyx. It is placed most contiguous to the fructification; or, in other words, immediately under the flower, which, in many plants, is contained in the perianth, as in a cup. On this account, this species of calyx has been denominated the flower-cup. It is also called the Empalement.

* Calyx, from καλυξ, and originally from καλυπτω, to cover: not, as some writers have supposed, from καλιξ, a cup.

† Perianthium, from περι, around; and ανθος, a flower.

VARIOUS species of perianthium are enumerated by Linnæus. Of these it is necessary that I should take particular notice.

A. THE *Perianthium fructificationis*, or perianth of the fructification, includes both the stamens and the germ; that is, the male and female organs of generation. This is the most common species of perianth. It is exemplified in Nicotiana, and various other plants, which are figured in these *Elements*.

B. THE *Perianthium floris*, or perianth of the flower, contains the stamens, but not the germ. This species of perianth is exemplified in Epilobium, Gaura*, and all those other vegetables which have the germ, or seed-bud, placed below the receptacle of the flower.

C. THE *Perianthium fructus*, or perianth of the fruit, contains the germ, but not the stamens. This is exemplified in the females of many of the plants of the two classes Monoecia and Dioecia†.

LINNÆA, Clove-tree, Morina, and several other vegetables, have two perianths, which very well illustrate the two last mentioned terms. In these vegetables, one of the perianths is appropriated to the flower, whilst the other belongs to the fruit.

a. WITH respect to the number of the leaves, or pieces, of which it is composed, the perianth has received the following names: viz. 1. *perianthium mono-*

* See Plate XVI. Fig. 2.

† See Plate XXIX. Fig. 2.

phyllum; a one-leafed perianth, composed of only one leaf; as in Tobacco, Thorn-Apple, Primrose, and many other plants. 2. *perianthium diphyllum*, a two-leaved perianth, consisting of two leaves; as in the Poppy, Claytonia, Fumatory. 3. *perianthium triphyllum*, a three-leaved perianth; consisting of three leaves, as in Dock, Magnolia, Tulip-tree, Annona, or Papaw, Podophyllum peltatum, or May-apple, &c. 4. *perianthium tetraphyllum*, a four-leaved perianth, consisting of four leaves; as in Water-Lily, Heath, the plants of the class Tetradynamia. 5. *perianthium pentaphyllum*, a five-leaved perianth, consisting of five leaves; as in Ranunculus, Glass-wort, Beet, Flax, and a great number of those plants the flowers of which have more than one petal. 6. *perianthium hexaphyllum*, a six-leaved perianth, consisting of six leaves; as in Lions-leaf, Berberry, Hillia parasitica, &c. 7. *perianthium heptaphyllum*, a seven-leaved perianth; consisting of seven leaves; as in Trientalis, or Winter-green. 8. *perianthium octophyllum*, an eight-leaved perianth, consisting of eight leaves, as in Mimusops, and Diapensia. 9. *perianthium decaphyllum*, a ten-leaved perianth; consisting of ten leaves; as in Galax. 10. *perianthium polyphyllum*, a many-leaved perianth; consisting of many leaves, or more than ten.

b. A ONE-leaved perianth is either, 1. *integrum*, entire; that is undivided, as in Genipa and Olax. 2. *bifidum*, two-cleft; cut into two segments or divisions, as in Tuberous Moschatel, Purslane, &c. 3. *trifidum*, three-cleft; cut into three segments, or divisions; as in Hermannia and Cliffortia. 4. *tetrafidum*, four-cleft; cut into four segments or divisions; as in Galium, and Elephant's head. 5. *quinquefidum*, quinquefid, or five-

cleft; as in Tobacco, and the greater number of flowers that are furnished with a calyx of one leaf. 6. *sexfidum*, six-cleft, or cut into six segments; as in Ginora americana. 7. *octofidum*, eight-cleft; as in Tormentil. 8. *decemfidum*, ten-cleft; as in Cinquefoil, and Herb-Bennet: and, 9. *duodecemfidum*, twelve-cleft; as in Purple Loosestrife, and Water-Purslane.

c. In respect to figure, a perianth is either, 1. *tubulosum*, tubular; or running in the form of a tube. 2. *patens*, spreading. 3. *reflexum*, reflex, or bent back; as in Asclepias, and Leontodon. 4. *inflatum*, inflated, hollow, or puffed up like a bladder; as in Physalis, called Ground-Cherry. 5. *globosum*, globose, or globular. 6. *clavatum*, club-shaped; as in Silene. 7. *erectum*, erect or upright.

d. In regard to the proportion which it bears to the corolla, the perianth is, 1. *abbreviatum*, abbreviated, or shorter than the tube of the corolla; as in Tobacco*, and most other plants. 2. *longum*, long; longer than the tube of the corolla. 3. *mediocre*, middle-sized; about the length of the tube of the corolla.

e. At its top, the perianth is, 1. *obtusum*, obtuse. 2. *acutum*, acute. 3. *spinosum*, spinous or thorny. 4. *aculeatum*, prickly. 5. *acuminatum*, acuminate.

f. The perianth is, 1. *æquale*, equal, having all the segments of the same size. 2. *inæquale*, unequal; when some of the segments are smaller than others. 3. *labiatum*, lipped; when the segments are irregular, and formed into two lips.

* See Plate XI. Fig. 1.

g. The perianth, with respect to its margin, is, 1. *integerrimum*, very entire. 2. *serratum*, serrated. 3. *ciliatum*, ciliate.

h. The perianth has received a variety of names, according to its surface. But these names have already been explained, in treating of the terminology of leaves*.

i. The situation of the perianth, with respect to the germen, is, 1. *superum*, superior; when the germen is under the lower part of the perianth. 2. *inferum*, inferior; when the germ is above the base of the perianth.

k. In respect to its duration, the perianth is either, 1. *caducum*, caducous, or falling off before the complete opening of the flower; as in the Poppy and the Barrenwort. 2. *deciduum*, deciduous, or falling off with the flower, that is the petals, the stamens, and the style; as in Berberry and the Cross-shaped flowers. 3. *persistens*, permanent; or continuing until the fruit has attained to maturity; as in the lip and masqued flowers, and several others.

l. 1. In respect to its composition, the calyx sometimes consists of a number of leaves, which are laid over each other, like tiles, or scales. This is the *perianthium imbricatum*, or imbricate calyx. Hawk-weed, Sow-Thistle, and many other Syngenesious plants, furnish us with beautiful instances of this species of calyx†. 2. Sometimes, the scales of the calyx spread wide, and are diffu-

* See pages 33, 34.

† See the Plate of Silphium terebinthinaceum.

sed on all sides, and not closely laid over each other, as in the preceding species. This last is the *perianthium squarrosum*, or squarrose calyx; of which we have examples in Thistle, Onopordum, Conyza, &c*. 3. In some plants, as in the Pink, Coreopsis, and others, the base of the calyx, which is simple, is surrounded, externally, by a series of distinct leaves, which are shorter than its own. To this species of calyx, Linnæus has given the name of *calyx auctus*, and Vaillant, *calyx calyculatus*, an increased calyx, caliculate, or calycled calyx. 4. The *perianthium scariosum*, or scariose perianth, is a species of calyx, which is tough, thin and semi-transparent; as in Statice Armeria, or Thrift, Centaurea glastifolia, &c. 5. The *perianthium turbinatum*, turbinate, or top-shaped perianth, is inversely conical, and shaped like a boy's top, or a pear. The Grislea secunda and Memecylon capitellatum exhibit instances of this species of perianth.

m. The perianthium is either, 1. *proprium*, proper, that is belonging to one flower; or, 2. *commune*, common, belonging to several flowers, collected together.

n. Some flowers, such as the Amaryllis, the Tulip, the Lily†, and many others of the liliaceous plants; also the Medeola‡, are said to be destitute of the perianth. But I shall afterwards have occasion to observe, that what the Swedish naturalist names, in these flowers, the corolla is deemed the calyx, by some other eminent botanists.

* See the Plate of Helianthus divaricatus.

† See Plate XIII. Fig. 2.

‡ See Plate XIV.

In the greater number of plants, the perianth is single. In Morina, Sarracenia* and some of the plants of the Mallow-family, as Althæa, Alcea, Malva, Lavatera, Gossypium, Hibiscus, &c. it is double.

Several circumstances relative to the perianth are necessarily delayed, until I shall have entered on the consideration of the corolla. Of the real and supposed uses of the perianth, I shall treat, after having finished the history of the various species of calyx. I have already mentioned the marks, or characters, by which the perianth may be distinguished from the bracte†.

2. The second species of calyx, which I have mentioned, is the *Involucrum*‡. This is called by Dr. Martyn, Involucre. It is chiefly restricted by Linnæus to the umbelliferous flowers, and is defined, by this writer, a calyx remote from the flower**.

This species of calyx is placed below the common receptacle, which, in the umbelliferous plants, is a number of footstalks, which all proceed from one common point or centre, and rise to the same height. Each of the footstalks is terminated by an umbel, which is similar, in its form and structure, to the large umbel, and is commonly, like it, furnished with an involucre. When a calyx of this kind is placed under the universal umbel, it is called, by Linnæus, *involucrum universale*, an universal involucre. When it is placed under the smaller or

* See Plate I. † See pages 78, 79.

‡ *Involucrum*, from *involvo*, to wrap up.

** "Calyx Umbellæ a flore remotus."

partial umbel, it is denominated *involucrum partiale*, a partial involucre. This is sometimes termed, *involucellum*, or involucret. Dr Withering calls it the Partial Fence.

In most of the umbelliferous flowers, such as the Hemlock, Fennel, Anise, and in other plants, not strictly umbelliferous, as the Cornus florida, or Dogwood, and other species of this genus, there is, besides the two involucres, a proper perianth, which is situated under each of the florets, or smaller flowers, of which the umbel is composed.

The involucre is composed of one or more leaves. When composed of one, it is denominated *involucrum monophyllum*, a one-leafed involucre, as in Bupleurum: when of two leaves, *involucrum diphyllum*, a two-leafed involucre, as in Euphorbia: when of three, *involucrum triphyllum*, as in Butomus and Alisma: when of four, *involucrum tetraphyllum*; as in Cornus: when of five, *involucrum pentaphyllum*; as in Daucus; and when of six, *involucrum hexaphyllum*; as in Hæmanthus.

The partial involucre, or involucret, consists either of two leaves, as in Artedia; of five, as in Hare's ear; or of many, as in Bishop's-weed, and Fennel-Giant.

The *involucrum dimidiatum*, dimidiate, or half-leaved involucre, is an involucre which is deficient on one side; as in Æthusa, or Fools Parsley.

It is difficult to say, in what very essential circumstance the involucre of those plants which are not umbelliferous, such as Cornus, or Dogwood, some species

of Anemone, &c. differs from the bractea, or bracte. It would seem, indeed, that Linnæus's principal reason for separating the involucre from the bracte was this, that he might make use of the former part in drawing his generic characters of the umbelliferæ.

3. The Amentum*, or Ament, called also Catkin, is a species of calyx, which consists of a great number of chaffy scales, that are dispersed along a slender thread, or receptacle. On account of its supposed resemblance to a cat's tail (though it bears as close a resemblance to the tails of many other animals as to that of the cat), it has received one of its English names, viz. catkin. The French call it Chaton; and many botanists have denominated it Catulus. The term amentum was used by the great Tournefort, before it was employed by Linnæus. The term is perfectly synonimous to the terms julus and nucamentum, which are employed by some botanists.

Linnæus defines the ament to be a composition of a calyx, and a common receptacle. The squamæ, or scales, which form this species of calyx, are mixed alternately with the flowers, and resemble the chaff in an ear of corn†.

The ament occurs very frequently in the xxist and xxiid classes of the Sexual System, the classes Monoecia and Dioecia, the particular characters of which are

* The term amentum, as used by the Roman writers, signifies a thong, a loop, a strap, or lash, to hold a sling, spear, or javelin by.

† For a fine representation of the ament, see the figure of Betula populifolia in this work.

afterwards to be explained*. In this place, however, it is proper to observe, that in the first mentioned class, the ament supports both male and female flowers, on the same root, or individual. This is the case in the Hornbeam, Walnuts, and Hickeries, Chesnut, Chinquepin, and many others. In the class Dioecia, the ament supports male and female flowers, on distinct roots, or individuals. This is the case in the Willows, Poplars, and many others.

It not unfrequently happens, that in plants of the class Monoecia, the male and female flowers are mixed together, or situated very close to each other; whilst in other plants, they are situated at a considerable distance from each other; but, in both instances, upon the same root, or individual.

In the latter case, the ament frequently supports flowers of one sex, and a calyx of the perianth-kind supports those of another sex. Thus, in the Corylus, or Hazle, the male and female flowers are placed remote from each other, upon the same root, or individual. The male flowers form an ament, whilst the females are inclosed in a perianth.

In the class Dioecia, there are some plants, such as Pistachia-nut, Juniper-tree, and Ephedra, or Shrubby Horse-tail, the male flowers of which are formed into an ament; whilst the female flowers are surrounded with a perianth.

In general, those flowers, whether they be male, or female, or both, which are supported by an ament, are

* See Part III.

destitute of the petals, or painted leaves. The Oak, the Beech, the Hazel, the Cypress, the Pistachia-nut, and several others, are illustrative of this observation.

4. The Spatha*, or Spathe, is a particular species of calyx, which opens, or bursts longitudinally, in form of a sheath, and produces a stem which supports one or more flowers.

The spatha consists either of one piece, as in the Narcissus, Snow-Drop, and the greater number of plants that are furnished with this species of calyx. 2. of two pieces, as in the Stratiotes, or Water-soldier; or, 3. of a number of scales, which are laid over each other like tiles; as in Musa, or Plantain-tree. The first species of spathe is called by Linnæus, *spatha univalvis*, a one valved spatha; the second, *spatha bivalvis*, a two-valved spathe; and the last, *spatha imbricata*, an imbricate spathe.

The *spatha dimidiata*, or halved spathe, is a spathe which invests the fructification only on the inner side.

According to the number of flowers, which it produces, the spathe has received different names, such as 1. *spatha uniflora*, a one-flowered spathe. 2. *spatha biflora*, a two-flowered spathe. 3. *spatha multiflora*, a many-flowered spathe.

Linnæus, in his *Fragments of a Natural Method*, has established an order of plants, to which he has given

* Spatha, in the Latin language, has various significations, such as a two-handed, or bastard sword, a spatula, the branch of a Palm-tree, &c. &c.

the name of *Spathaceæ*. This order embraces a number of very fine vegetables, some of which have already been mentioned, in a former part of this work*. I shall here give the list of all the genera that were known to Linnæus. They are all furnished with that particular species of calyx which I have been considering. Allium, Amaryllis, Bulbocodium, Colchicum, Crinum, Galanthus, Gethyllis, Hæmanthus, Leucojum, Tulbagia, Narcissus, Pancratium. The Massonia of Thunberg, the Cyrtanthus of the younger Linnæus, and the Agapanthus of L'Heritier, also belong to this order.

Of some of these plants, I shall take further notice in speaking of the plants of the class Hexandria†. At least three of the genera, viz. Allium, Amaryllis, and Pancratium, are indigenous to the United-States.

5. The Gluma‡, or Glume, is a species of calyx restricted to the gramina, or grasses. It is formed of valves, and embraces the seed. This species of calyx, which is also called the Husk or Chaff, is frequently terminated by a stiff-pointed prickle, called the awn, or beard.

a. The glume has received different names, according to the number of flowers which it supports: such as, 1. *gluma uniflora*, a one-flowered glume. 2. *gluma biflora*, a two-flowered glume. 3. *gluma triflora*, a three-flowered glume. 4. *gluma multiflora*, a many-flowered glume.

* See page 13.

† See Part III.

‡ Gluma, from *glubo*, to bark, or take the bark from a tree.

b. VARIOUS appellations have also been given to the glume, according to the number of its valves: viz. 1. *gluma univalvis*, an univalvular, or one-valved glume. 2. *gluma bivalvis*, or bivalvular glume; consisting of two scales. This is the most common species of glume. 3. *gluma multivalvis*, a multivalve, or many-valved glume; having more than two scales, or valves.

c. The glume is, 1. *colorata*, coloured; of any colour but green, which is the general colour of this species of calyx. 2. *glabra*, smooth. 3. *hispida*, hispid; shaggy or rough with hairs.

d. THE glume is either, 1. *aristata*, awned; having an awn. 2. *mutica*, awnless; blunt, or without any point at the end.

THE *Arista*, or awn, is a slender and sharp process, which issues from the glume of many grasses. In English, this part is commonly called the Beard. But this latter term ought not to be applied to the awn, since it is systematically appropriated to a particular species of pubescence*.

To the awn, as well as to the glume itself, various names have been applied, such as the following: viz. 1. *terminalis*, terminating, fixed to the top of the glume. 2. *dorsalis*, dorsal; placed on the back, or outside of the glume. 3. *recta*, straight; issuing from the glume in a perpendicular direction. 4. *tortilis*, twisted, or coiled like a rope. 5. *recurvata*, recurved; or bent back; and, 6. *geniculata*, geniculate; or bent like the knee-joint.

* See page 88

Plants that are furnished with the species of stem which we have called the culm*, and with the glume, in place of a calyx, are known among botanists by the name of *Plantæ Culmiferæ*, or Culmiferous plants. By Linnæus they are denominated *Gramina*, or grasses. Wachendorf† calls them *Glumosæ*. The greater number of these grasses are furnished with hermaphodite flowers, and belong to the third class of the Sexual System. Some important species belong to the other classes, particularly to the sixth class, where we find the Oryza, or Rice; and to the twenty-first class, to which belongs the Zea Mays, or Indian-corn, &c. Some species belong to the twenty-third class. Haller and Scheuchzer affirm, that in *many* of the grasses, they have found but two stamens. This is denied by Linnæus. But the authority of Haller ought not to be questioned.

Linnæus, perhaps without the best foundation, considered the grasses as the most simple of all plants, in regard to their structure. He has also observed, that very few of these vegetables have any taste; that many of them are insipid, like the Olera, or pot-herbs; that a very small proportion are fragrant; and that none of them are poisonous‡.

Many of the grasses, however, have a very agreeable sweetish taste; some of them possess an astringent quality; and in this very interesting class, there are some very fragrant plants, such, not to mention others, as the Seneca-grass of the United-States. This has a most agreeable smell, very similar to that of the pod of the

* See page 24—26. † Horti Ultrajectani Index. 1747.

‡ Prælectiones in Ordines Naturales Plantarum. p. 137.

Vanilla. It is much esteemed by the Senecas, and other Indian tribes. From the Senecas, it receives its name.

That none of the grasses are poisonous, is not consonant to the observations of other botanists. The Lolium temulentum, or Darnel, is commonly esteemed a noxious species of grass. This is the plant which Virgil, in the following lines, calls infelix, or unhappy.

" Prima Ceres ferro mortales vertere terram
" Instituit: cum jam glandes atque arbuta sacræ
" Deficerent sylvæ, et victum Dodona negaret.
" Mox et frumentis labor additus: ut mala culmos
" Esset robigo, segnisque horreret in arvis
" Carduus: intereunt segetes: subit aspera sylva,
" Lappæque tribulique: interque nitentia culta
" Infelix Lolium, et steriles dominantur avenæ."

Georgic. Lib. I. l. 147—154.

" First pitying Ceres taught the famish'd swain
" With iron shares to turn the stubborn plain,
" What time the arbute fail'd, and fail'd the food
" Shower'd from the oak along Dodona's wood.
" New cares the corn pursu'd: here mildew fed,
" There thistles rear'd aloft their horrent head:
" The harvest perishes; with prickles crown'd,
" The bur and caltrop bristle all around:
" Their baleful growth wild-oats and Darnel rear,
" And tow'r in triumph o'er the golden ear!"

Sotheby.

The Darnel is, unquestionably, a noxious plant. Actual experiments, however, seem to show, that it is much less poisonous than has been generally imagined. Manetti* observes, that this grain may be eaten,

* Delle specie diverse di frumento e di pane, &c. &c. Firenze: 1765.

with impunity, provided there be mixed with its meal, a larger proportion of the meal of other *cerealia*, or grains; and the compound mass be subjected to a second, but gentler, baking; care, at the same time, being taken, not to eat the bread too warm. He applies the same observations to the Bromus secalinus, or Field Brome-grass.

Upon the whole, the grasses constitute one of the most natural families of plants with which we are acquainted. It will be a happy era in Botany (the era is, unquestionably, remote), when the labours of learned men shall have disposed of all, or the greater number of plants, into classes or orders as unexceptionable, and as agreeable to the scheme of Nature, as is the order of *Gramina*.

6. The Calyptra*, or Calyptre, is said to be the calyx of the mosses, covering the anther, or male organ, of this family of vegetables, like a hood, monks' cawl, or extinguisher. But, the calyptre cannot, I think, be considered as a real calyx. It is, moreover, to be observed, that the part, which Linnæus calls the anther of the mosses, is known to be the capsule, or pericarp, of these vegetables.

The calyptre is either, 1. *recta*, straight; equal on every side; or, 2. *obliqua*, oblique, bent on one side†.

7. The Volva, or Ruffle‡, as Dr. Withering calls it, is defined to be the membranaceous calyx of a fungus

* Calyptra, from καλυπτω, to cover.

† See Plate XXX. ‡ See Plate XXX.

plant. It is also called the Curtain. This ought not to be considered as a species of calyx, and is, to all appearance, a part of very little consequence in the vegetable economy.

The volva is said to be, 1. *approximata*, approximating; when it is placed upon the stem of the fungus, near the cap. 2. *remota*, remote; when it is at a distance from the cap.

In order to convey to the reader some idea of the relative proportion that obtains, in respect of number, between the several species of calyx which I have enumerated, it will not be amiss to notice the following observations, by Dr. Alston, of Edinburgh. In the year 1753, that learned, but acrimonious opposer of the Sexual System of Linnæus, published his *Tyrocinium Botanicum*. At this period, the *Genera Plantarum* of Linnæus, contained only 1021 genera, or families of plants. Of these, according to the professor, 673 have for their calyx a perianth: 72, a spathe: 75, an involucre: 29, a glume: 18 an ament: and, 3, a calyptre. Of the volva, or ruffle, Alston has taken no notice; nor ought he to be blamed for the omission: for this imaginary calyx is never once named by Linnæus, in drawing the characters of the genera of Fungous plants, which were, at that time enumerated, in the *Genera Plantarum*. Dr. Alston also remarked, that about 110 genera were entirely destitute of the calyx; that 25 have both a perianth and an involucre; and a few both a perianth and a spathe.

Since the time of Alston, the accessions to Botany have been immense. But I have not leisure to pursue the subject of the relative proportion of the different spe-

cies of calyx, in the many thousand species of plants that are now known. I shall only observe, in this place, that within the last twenty or thirty years, Botany has been enriched with a very great proportion of plants, that are furnished with two of the species of calyx; I mean the glume and the calyptre.

In his attempt to establish the analogy between the animal and the vegetable kingdoms, Linnæus has designated the calyx by the name of *thalamus floris*, or the conjugal bed*. But this poetical language seems but ill adapted to the grave dignity of science. I may add, that the Swedish naturalist would have used a less exceptionable phrase, had he considered the perianth merely, as the conjugal bed. With no manner of propriety can this term be extended to the spatha, the volva, and calyptra.

Dr. Grew has observed, that the design of the empalement, or perianth, is to enclose, secure, and support the other parts of the flower; to be their security before its opening, by intercepting all extremities of weather; and afterwards to be their support, by containing all the parts in their due, and most graceful posture. Hence, continues this celebrated vegetable physiologist, we have the reason why the calyx is frequently various, and sometimes wanting. Some flowers have none, as Tulips; because having a fat and firm leaf, or petal, and each leaf likewise standing upon a broad and strong basis, they are thus sufficient to themselves. Carnations, on the contrary, have not only an empalement, but that, for greater support, of one leaf: for, otherwise, the foot of each leaf

* "Calyx ergo est *Thalamus*, Corolla *Auleum*," &c. Philosophia Botanica, &c. p. 92.

or petal, being very long and slender, most of them would be apt to break out of compass. In the same flower, the top of the empalement is indented, that the indentments may protect the petals; by being lapped over them before their expansion, and afterwards may support and prop them up, by being spread under them*.

THERE can, perhaps, be little doubt, that the calyx, or more specifically speaking, the perianth, is of essential use, as Dr. Grew asserts, in giving security or protection to the petals, and other parts of the flower. In many plants, the calyx likewise serves the office of a pericarp, or seed-vessel; as in the plants of the order Gymnospermia, in the class Didynamia. But these, I am inclined to think, cannot be the only uses of the perianth. It is probable, that this part is concerned in the great business of vegetable respiration. This opinion, which has been suggested by some ingenious writers, will appear more probable from the view which will afterwards be given of the uses of the corolla, and the near relations of this part of the fructification to the perianth. With respect to the involucrum, I have already hinted at the affinity which this species of calyx bears to the bracte†. There seems to be as good reason to consider the involucre of many plants, a pulmonary system, as to consider the bracte in this light‡.

OF Linnæus's opinion concerning the origin of the calyx, viz. that it is a continuation of the cortex, or outer bark, of the vegetable, I shall take more particular notice afterwards.

* Grew, as quoted by Milne.

† See pages 114, 115

‡ See page 80—82.

§. II.

THE Corolla*, which some English writers have denominated the Corol, is the second of the seven parts of fructification already enumerated. Linnæus defines it "the liber or inner bark of the plant present in the fructification†." I shall afterwards examine the propriety of this anatomical definition.

SOME writers have translated the term corolla by Blossom. But Dr. Martyn has observed, that "blossom "has a more contracted signification in English, being "usually applied to the flowers of fruit-trees." I may add, that in the United-States, the term blossom, though it is by no means exclusively restricted to the flowers of fruit-trees, is generally employed to denote the whole of the flower, including the calyx (at least the perianth), the corolla properly so called, and the male and female organs.

THE petals of the corolla are frequently called, both in common language, and in the writings of poets and philosophers, "the leaves of the flower." Thus Thompson calls the petals of the Helianthus, or Sun-flower, "yellow leaves." "AND ALL YONDER STARS INNUME-"RABLE, WITH THEIR DEPENDENCIES, says an amiable philosopher‡, MAY PERHAPS COMPOSE BUT THE LEAF OF A FLOWER IN THE CREATOR'S GARDEN."

* Corolla, in the Latin, literally signifies, a little crown, or garland; a chaplet, a coronet.

† Liber plantæ in Flore præsens." Philosophia Botanica, &c. p. 52.

‡ The late Mr. David Rittenhouse.

But this language is not sufficiently precise and specific for the purpose of science. To avoid all ambiguity, I shall retain, without any alteration, the Latin word Corolla, which ought, I think, to be preferred to Dr. Darwin's word Corol. The segments of the Corolla, I shall continue to call Petals.

The corolla, according to Linnæus, consists of two parts, viz. the *Petalum*, or Petal, and the *Nectarium*, or Nectary. The last, however, is not always a part of the corolla; and, therefore, at present, I shall take no further notice of it.

It is said, that, in general, the corolla may be distinguished from the perianth, by the fineness of its texture, and the gayness of its colours; the perianth, or calyx, being usually rougher, and thicker, and of a green colour. But to this rule there are many exceptions. Thus, in Bartsia*, the perianth is coloured, even more so than the corolla. The perianth of Fuschia coccinea is a bright scarlet: the corolla, indigo coloured. The perianth of Dombeya lappaceaf, before the opening of the flower, is of a crimson colour. It afterwards becomes green. The corolla is of a brownish-violet colour. Moreover, the corolla of Daphne Laureola is green. The calyx is painted. The perianth and the corolla of Bignonia radicans (Trumpet-flower), are both of the same colour. It is necessary, then, to have recourse to other marks, by which these two parts of the fructification may be accurately discriminated from each other.

* See Plate IV.

† See a figure and description of this plant, in the *Stirpes Novæ* of L'Heritier. Fasc. II. p. 33. 34. pl. XVII

LINNÆUS makes the distinction between the corolla and the perianth to consist in this circumstance, that the former has its segments, or petals, disposed alternately with the stamens; whereas the perianth has its parts, or leaflets, arranged opposite to the stamens. "This rule, says Dr. Milne, "determines with precision, in such flowers as want either the calix, or petals. "Thus, in Pellitory, Wild Orach, and Nettle, one of the "two covers is wanting. Which is it? Am I to infer "that the single cover present is the corolla, because the "finer and more principal part? Nothing would be more "erroneous than such an inference; many flowers, as "Water-Purslane, Ruellia, and Bell-flower, which ge-"nerally have both covers, are found occasionally to "lose the petals, but never the calix. How then, am I "to proceed? Apply the rule mentioned above. I do so, "and finding the divisions of the only cover that is pre-"sent, to stand opposite to the stamina, I conclude that "cover to be the calix.

"That the rule just mentioned, is founded in the "natural situation of the parts in question, will appear, "by examining any number of complete flowers in the "fourth and fifth classes of Linnæus's Sexual Method. "In the former of these classes, the number four, in "the other, the number five, is predominant; and, as "both covers are present, the opposition and alterna-"tion alluded to, becomes distinctly visible*."

NOTWITHSTANDING what has been said, there is, on many occasions, a great difficulty in distinguishing

* Milne's Botanical Dictionary. &c. art. Corolla. See, also, Philosophia Botanica, &c. p. 57, 58. §. 90.

the corolla from the perianth. Linnæus himself confesses, that Nature does not seem to have placed any absolute limits between the calyx and the corolla*. This, I think, must be admitted as a well-founded position; especially if it be not true, that the calyx is exclusively derived from the outer, and the corolla from the inner, bark.

The learned Mr. A. L. De Jussieu, defines the corolla to be that cover of the flower, "which is surrounded by the calyx, or very rarely naked; is a continuation of the liber, or inner bark, and not of the cortex or outer bark, of the peduncle; is not permanent, but commonly falls off with the stamens; which involves or crowns the fruit, but never grows fast to it; and which almost always has its segments, or divisions, ranged alternately with the stamens." From this view of the subject, the painted petals of the Narcissus are regarded by Jussieu, as a true perianth; as, indeed, Tournefort† had taught a long time ago; and by the same rule, the Hyacinth, and other liliaceous plants very nearly allied to the Narcissus, are furnished with a perianth, but are destitute of the corolla‡.

Mr. Adanson, a botanist of great learning, has also observed, that in the liliaceous plants, what is called by Linnæus the corolla, is, in reality, a perianth, according to the very principles of the Swedish naturalist.

* "Limites inter Calycem & Corollam absolutos, naturam non posuisse; "patet ex *Daphnide*, ubi connata ambo, & margine omnino unita, veluti folium *Buxi*." Philosophia Botanica, &c. p. 58. §. 90.

† Isagoge in Rem Herbariam. p. 72.

‡ Genera Plantarum secundum Ordines Naturales Disposita, &c. Introductio. p. xiii. Parisiis: 1789.

Linnæus has not only acknowledged the difficulty of distinguishing the calyx from the corolla, but in his different works, he has confounded these two parts with each other. Thus, in his *Genera Plantarum*, that part which he names the corolla of Rhamnus, he denominates the calyx in the *Systema Vegetabilium*. Again, in his *Genera*, he calls the cover of Polygonum a calyx, or perianth; but in the *Systema Vegetabilium*, he calls it the corolla. Other instances, of a like kind, might be pointed out. I may add, that Linnæus calls the cover of Phytolacca*, the corolla. But this cover is, unquestionably, a calyx, if any regard be due to the Linnæan rule of the relative disposition of the stamens, and the parts of the cover.

Sensible of the great difficulty which not unfrequently occurs in distinguishing the corolla from the calyx, the late learned Nat. Jos. De Necker, has called† both the corolla and the calyx by one name, viz. *Perigynanda*‡, a name derived from the Greek, and signifies the envelope, the cover, or wrapper of the stamens, and the pistils. Our author distinguishes the perigynanda, when there are two covers, into the outer and the inner. The inner answers to the corolla, and the outer to the calyx of Linnæus.

Hedwig, who is generally supposed to have disproved the ideas of Linnæus, concerning the origin of the calyx and corolla, from the outer and the inner bark of

* See Plate XVII. Fig. 4. A. B.

† In his Corollarium ad Philosophiam Botanicam Linnæi spectans, &c. &c. in his Phytozoologie Philosophique, &c. and other works.

‡ Perigynanda, from περι, around, γυνη, a woman, and ανηρ a man.

the stem, denotes both the calyx and the corolla, by the name of *Perigonium**. When there are two coverings (the calyx and corolla of Linnæus), he designates one by the name of the *internal* perigonium, and the other by the name of the *external* perigonium. When there are three covers, as is the case in Morina, several malvaceous plants, &c. he calls the third one, the *intermediate* perigonium.

I HAVE said, that "the corolla, according to Linnæus, consists of two parts, viz. the *Petalum*, or Petal, and the *Nectarium*, or Nectary."

THE petal constitutes the principal part of the corolla. It surrounds both the stamens and the pistils, or the male and female organs of generation. It consists of one or more pieces.

ACCORDING to the number of its petals, the corolla has received the following names. 1. *corolla monopetala*, one-petalled, or monopetalous, consisting of only one petal; as in Convolvulus†, Tobacco†, and many others. 2. *corolla dipetala*, dipetalous, or two-petalled; as in Commelina**, Circæa, and others. 3. *corolla tripetala*, three-petalled; consisting of three distinct petals; as in Sagittaria††, Alisma, &c. 4. *corolla tetrapetala*, tetrapetalous, or four-petalled; as in the plants of the class Tetradynamia. 5. *corolla pentapetala*, or five-petalled; consisting of five distinct petals; as in Marsh-

* *Perigonium*, from περι, about, and γονος, seed.

† See Plate XI. Fig. 3.

‡ See Plate XI. Fig. 1.

** See Plate X. Fig. 1.

†† See Plate XVIII.

Marygold, the *Umbellatæ*, &c. 6. *corolla hexapetala*, hexapetalous; or six-petalled; consisting of six petals; as in Lily, Tulip, Amaryllis, Pancratium, &c. 7. *corolla polypetala*, polypetalous, consisting of many petals. (This term is sometimes used by Linnæus, in opposition to the term monopetalous. By many writers, it has been put for a corolla of more than six petals). Of the polypetalous plants, some have nine petals, as the Liriodendron; and some an indefinite number, as Water-Lily, and Globe-Ranunculus.

When the corolla consists of only one piece, as in the monopetalous corolla, the whole corolla, in the Linnæan sense of the word, is a petal.

A flower which has no petals, or corolla, is termed by the botanists, *apetalus*, or *apetalus flos*, an apetalous flower. This term was adopted by Linnæus, from Tournefort. It is equivalent to the term *imperfectus*, or imperfect, of Rivinus, Knaut, and Pontedera: the term *stamineus* of Ray; the *incompletus* of Vaillant; and the *capillaceus* of some other botanists.

The existence of apetalous flowers has been denied by Christian Knaut‡. But we well know, that there are not a few vegetables whose flowers are entirely destitute of the petals. If the notions of Mr. Jussieu and some other botanists, concerning the calyx and the corolla, be admitted as just, it must then be granted, that very many plants, and some of them the most beautiful with which we are acquainted, are strictly, apetalous.

‡ In his Methodus Plantarum genuina. Hallæ: 1716.

THE number of petals of which a corolla consists is determined from the base of the corolla. The rule of Rivinus is to reckon as many petals, as the parts into which the flower, when it falls, resolves itself. This criterion will, in most instances, be found very exact. But, in some instances, it is found to be insufficient for our purpose. For the corolla of the Vaccinium Oxycoccos, or Cranberry, is unquestionably, only one-petalled; but this flower, upon falling, resolves itself into four distinct leaves. From the difficulty that occurs, in some instances of determining, whether a corolla consists of one or more petals, we find that Tournefort reckons the corolla of the Mallow-tribe of plants, monopetalous; whilst Linnæus considers it as pentapetalous.

a. DIFFERENT names are assigned to different parts of the corolla. Such are the following. 1. The *tubus*, or tube, is the lower part of a monopetalous corolla; as in Tobacco, &c. 2. The *unguis*, or claw, is the lower part of a many-petalled corolla, by which it is fixed to the receptacle; as in Lily, &c. 3. The *limbus*, or limb, is the border, or upper dilated part, of a monopetalous corolla. 4. The *lamina*, or border, the upper, spreading part of a many-petalled corolla. (Linnæus has not uniformly used the term *limbus*, in one sense: for he sometimes employs it for the dilated part of a many-petalled corolla).

b. IN regard to its divisions, the corolla is, 1. *bifida*, bifid, or two-cleft; when each petal is divided into two; as in Chickweed, and Enchanters-Nightshade, 2. *trifida*, three-cleft; when each petal is divided into three parts; as in Holosteum, and Hypecoum. 3. *tetrafida*, four-cleft; as in Cucubalus*. 4. *quinquefida*, five-cleft; as in Basard-

* See Plate XVII. Fig. 3.

Rocket. 5. *multifida*, many-cleft; as in Convolvulus Soldanella. (This term is equivalent to the term *laciniatus flos* of Tournefort.) 6. *bipartita*, two-parted; simple, but divided almost down to the base. 7. *tripartita*, three-parted, simple, but divided into three parts, almost down to the base. 8. *laciniata*, laciniated; divided into segments.

c. In respect to equality, the corolla is, 1. *regularis*, regular; equal in the figure, size, and proportion of the parts; as in Privet, Lilac, Jasmin, &c. 2. *irregularis*, irregular; when the parts of the limb differ in figure, magnitude, or proportion; as in Aconite, Lupin, and Dead-Nettle. 3. *inæqualis*, unequal; having the parts corresponding, not in size, but in proportion; as in Butomus umbellatus*. 4. *æqualis*, equal; when the petals are of the same size and figure; as in Primula, Limosella, &c. (There does not appear to be any essential difference between the terms *æqualis* and *regularis*: and, perhaps, as Dr. Martyn observes, the term regular expresses the idea better). 5. *difformis*, difform, anomalous, or irregular; when the petals, or their segments, are of different forms.

d. In respect to figure, the corolla is, 1. *globosa*, globose, globular, or spherical; round like a ball; as in Trollius, or Globe-Ranunculus. 2. *campanulata*, campanulate, bell-shaped, or bell-formed; swelling or bellying out, without any tube; as in the Campanula, Convolvulus†, Atropa, and many others. (This term is,

* See Plate XVI. Fig. 3. According to Jussieu, the cover of Butomus is a calyx, or perianth.

† See Plate XI. Fig. 3.

in strict propriety, applied to the monopetalous corollas only: yet, sometimes, it is extended also to flowers that are polypetalous. 3. *infundibuliformis*, funnel-shaped; having a conical border rising from a tube; as in Lithospermum, Stramonium, Henbane, Tobacco*, and many others. 4. *hypocrateriformis*, salver-shaped; rising from a tube with a flat border; as in some of the plants called *Asperifoliæ;* in Diapensia, Aretia, Androsace, Hottonia, Phlox, Samolus, &c. 5. *rotata*, wheel-shaped; spreading flat without any tube; as in Borago, Veronica†, Physalis‡, Verbascum, and others. 6. *cyathiformis*, cyathiform, glass-shaped, or cup-shaped; cylindrical, but widening a little at the top. 7. *urceolata*, pitcher-shaped; bellying-out like a pitcher. 8. *ringens*, ringent, irregular, gaping with two distinct lips; a one-petalled corolla, the border of which is commonly divided into two parts, to which the botanists have given the names of upper and lower lip. The former is sometimes called the *galea*, or helmet: the latter, the *barba*, or beard. The opening between the two lips is named *rictus*, or the gap: the opening of the tube, *faux*, the throat or jaws: the prominent swelling in the throat, *palatum*, or the palate; and the upper part of the tube, *collum*, or the neck. Most of the flowers in the XIVth class of the Sexual System, Didynamia, are furnished with this species of corolla**. 9. *personata*, personate, or masked: said, by Linnæus, to be a species of ringent corolla, but closed between the lips by the palate. "But "surely (as Dr. Martyn observes), ringent, or gaping

* See Plate XI. Fig. 1.

† See Plate IX. Fig 2.

‡ See Plate XI. Fig. 2.

** See Plate XIX. Fig. 1.

" with the lips closed, is a contradiction in terms. It " would be better to define it, a species of labiate co- " rolla, which has the lip closed." 10. *cruciata* or *cruciformis*, cruciform or cross-shaped; consisting of four equal petals, which spread out in form of a cross. This species of corolla is exemplified in most of the plants of Linnæus's xvth class, *Tetradynamia**. 11. *papilionacea*, papilionaceous, or Butterfly-shaped; irregular, and most commonly consisting of four petals, to which Linnæus has given three different names: viz. the *carina*, the *vexillum*, and the *alæ*. The carina, or keel, is the lower petal, which is shaped somewhat like a boat; the vexillum, or standard, is the upper petal, which spreads and rises upwards; and the alæ, or wings, are the two lateral petals, which stand singly, being separated by the keel. 12. *rosacea*, rosaceous, or rose-like; consisting of four or more regular petals, which are inserted into the receptacle, by a short and broad claw; as in the Wild-Rose. (To plants which are furnished with this species of corolla, Tournefort has given the name of *Rosacei*. They constitute his sixth class.) 13. *undulata*, waved or undulated; the surface rising and falling in waves, or obtusely, not in angles; as in Gloriosa superba, and Gloriosa simplex. 14. *plicata* plaited; or folded like a fan; as in Convolvulus. 15. *revoluta*, revolute, rolled back or downwards; having the petals rolled back; as in Asparagus, Medeola†, and Lilium‡. 16. *torta*, twisted; as in Nerium, Asclepias, Vinca, &c.

e. In respect to its margin, the corolla is, 1. *crenata*, crenate; as in Linum, Dianthus chinensis, &c. 2. *ser-*

* See Plate XIX. Fig. 3.

† See Plate XIV.

‡ See Plate XIII. Fig. 2.

rata, serrate; as in Tilia, Alisma, &c. 3. *ciliata*, ciliate; as in Rue, Menyanthes, Tropœolum, Gentiana ciliata, &c. (These terms have already been explained, under the head of the nomenclature of leaves)*.

f. In respect to its surface, the corolla is, 1. *villosa*, villose. 2. *tomentosa*, tomentose. 3. *sericea*, silky, or covered with very soft hairs, pressed close to the surface. 4. *pilosa*, hairy. 5. *barbata*, bearded; as in Dianthus barbatus. 6. *imberbis*, beardless: opposed to bearded. 7. *cristata*, crested; furnished with an appendage, like a crest or tuft; as in Polygala, Iris cristata, &c.

g. In respect to its proportion, the corolla is, 1. *longissima*, very long; several times longer than the calyx; as in Lobelia longiflora, &c. 2. *brevissima*, very short; not as long as the calyx; as in Sagina procumbens, &c.

h. In respect to its situation, the corolla is, 1. *supera*, superior; having its receptacle above the germ. 2. *infera*, inferior; having its receptacle below the germ.

i. In point of duration, the corolla is, 1. *caduca*, caducous; continuing only until the expansion of the flower, and then falling off; as in Herb-Christopher, and Meadow-Rue. 2. *decidua*, deciduous; when the petals fall off with the rest of the flower. 3. *persistens*, permanent; continuing until the fruit has attained to maturity; as in Water-Lily. 4. *marcescens*, withering or shrivelling; withering on the stalk, without dropping; as in Campanula, Orchis, Cucumber, Gourd, Bryony, &c.

* See pages 32, 33.

In some plants, even of the same species, the corolla is very caducous, or transitory; in others, it is more permanent. We are not acquainted with all the circumstanstances which thus essentially vary the longevity of the corolla. It is, however, a well known fact, that double-flowers, in general, last much longer than single ones. Thus, in single Poppies, the corolla falls off in a few hours, whilst in double ones it lasts for several days*. The double blossoms of the Cherry last much longer than the single blossoms of the same tree. It would, indeed, seem to be a general law of nature, that a longer duration of life is conceded to those vegetables, as well as animals, which are prohibited by their structure, or other circumstances, from the function of generation. In double blossoms, the organs of generation being obliterated, impregnation cannot take place; but in single blossoms, the parts being perfect, there is no obstacle to the generative act. In like manner, we find that the mule, which (in general at least) is not fertile, lives longer than the horse or the ass, by which he is begotten; and it has, long since, been observed, that the term of life of the locust and other species of insects, as well as of various species of birds, may be very considerably protracted, by prohibiting them from all intercourse with their respective females.

k. In respect to its composition, the corolla is, 1. *compositа*, compound; consisting of several florets, included within a common perianth, and sitting upon a common receptacle; as in the plants of the class Syngenesia. 2. *ligulata*, ligulate, or strap-shaped; when the florets have their corollets flat, spreading out towards the end,

* Dr. James Edward Smith.

with the base only tubular; as in the plants of the first order of Syngenesia*. 3. *tubulata*, tubulous; when all the corollets of the florets are tubular, and nearly equal. 4. *radiata*, radiate, consisting of a disk, in which the corollets or florets are tubular and also regular; and of a ray, in which the florets are irregular, and commonly ligulate.

l. In regard to its colour, the corolla of different vegetables assumes almost every known colour.

Linnæus, ever in pursuit of analogies, has distinguished the corolla by the name of *auleum floris*, or palace in which the nuptials of the plant are celebrated. But this species of language teaches us nothing very determinate concerning the uses of the corolla. Our author has also observed, that the corolla serves as wings to waft the flower about, and thus to assist in the business of impregnation.

It seems highly probable, that one use, among others, of the corolla, is that of sheltering and defending the stamens and other important parts, which are situated within this beautiful structure. But it is by no means probable, that this is the only use of the corolla.

Sprengel observes, that the corolla is "an attrac-
"tion to insects, and a convenient seat or bed for them
"while extracting the honey, and promoting the im-
"pregnation of the flower†." But who will seriously believe, that Nature has exerted so much care and skill in the construction of the beautiful petals of flowers,

* See Plate XXII.

† Sprengel, as quoted by Dr. J. E. Smith.

merely to form a palace for insects, whilst they are aiding in a work, which, in innumerable instances, is fully accomplished without the least of insectile aid?

Dr. Darwin is of opinion, that the corolla forms a pulmonary system "totally independent of the green "foliage," and that this respiratory system belongs to the sexual or amatorial parts of the fructification only! He asserts, that each petal is furnished with an artery, "which conveys the vegetable blood to its extremities, "exposing it to the light and air under a delicate moist "membrane, covering the internal surface of the petal, "where it often changes its colour, as is beautifully "seen in some party-coloured Poppies, though it is "probable (he observes) that some of the iridescent "colours of flowers may be owing to the different de-"grees of tenuity of the exterior membrane of the pe-"tal, refracting the light like soap-bubbles.

"The vegetable blood (continues our learned au-"thor) is then collected at the corol-arteries, and re-"turned by correspondent veins, exactly as in the green "foliage, for the sustenance of the anthers, and stigmas, "and for the important secretions of honey, wax, essen-"tial oil, and the prolific dust of the anthers, and thus "constitutes a pulmonary organ."

In support of this opinion, Dr. Darwin has adduced several very ingenious arguments, for the full exposition of which, I must refer to his *Phytologia**, a work replete with learning, and marked, in every page, with the genius of the British Lucretius. It must be con-

* Sect. IV.

fessed, however, that much of mere hypothesis is attached to Darwin's observations, concerning the uses of the parts of vegetables. He has too frequently assumed as points completely established, points that are still involved in great uncertainty. Thus, a fundamental part of this author's reasoning concerning the use of the corolla is the assumption of the fact, that in this part of the fructification, there is a two-fold system of vessels, corresponding to the pulmonary artery and veins of animals. Now, many experiments, which I have made, compel me to entertain some doubts relative to the existence of an arterial and venal system in the corolla. What I have already said concerning the leaves*, may, with equal propriety, be extended to the corolla. I have often succeeded in colouring this part of the plant, with the juice of the Phytolacca, and other colouring matters: but I have not been able to convince myself, that the colouring matter is exclusively carried, in the first instance, along the upper surface of the corolla; and I never could decidedly perceive, that it was returned by a venous system, on the under side of the petals. I do not mean, however, to deny the existence of arteries and veins in the corolla. I wish to proceed with caution.

Many experiments remain to be made, before the uses of the corolla can be completely demonstrated, to the satisfaction of naturalists and philosophers. I am disposed, in the meanwhile, to believe, that both this part and the calyx are essentially concerned in the office of vegetable respiration. Indeed, as nature does not seem to have drawn any certain line of discrimination between the calyx and the corolla, it must, perhaps, be

* See pages 57—59.

admitted, that both of these parts perform the same office, whatever that office may be.

I HAVE already particularly mentioned the curious fact of the longer duration of the double flowers, than of single flowers, in the same species of plant. The ingenious Dr. Smith thinks it probable, that this circumstance, "combined with other observations," may "lead " to a discovery of the real use of the corolla of plants, " and the share it has in the impregnation*." I shall not pretend to determine, how far there may be a solid foundation for this idea. But the fact itself is very interesting, and will be again reverted to, in the sections on vegetable life and generation†.

THE importance of the corolla, as an organ essentially concerned in the business of respiration, or in that of impregnation, is, perhaps, *somewhat* diminished by the following fact. Many plants, in certain situations of climate, heat, &c. are observed to drop all, or the greater number of, their petals; and yet their seeds ripen, and come to full perfection. Such flowers are called mutilated flowers *(mutilus flos)*, and their mutilation has generally been ascribed to the agency of heat. This is, doubtless, a frequent cause of the falling of the petals of plants. But it cannot be the only cause: for some of the plants which are natives of warm and temperate climates, are observed to drop their petals in cold climates. Indeed, Linnæus has asserted, that the falling of the petals is generally owing to a deficiency of the requisite

* Philosophical Transactions, for 1788. See, also, Tracts relating to Natural History. p. 177, 178. London: 1798.

† See Part II.

heat*. He mentions the following plants as instances of *flores mutilati*: viz. Ipomoea hepaticæfolia, Campanula Pentagonia, Ruellia clandestina, Violæ (Violets of various species), Tussilago Anandria, and Lychnis apetala. To this list may be added the following plants, viz. Campanula perfoliata, Salvia verbenaca, Silene portensis, Cistus salicifolius, Cistus guttatus, Lamium amplexicaule, and many others.

The learned Mr. Adanson informs us, that the following plants lose their petals at Paris, viz. Glaux maritima, Peplis, and Ammannia.

In investigating the characters of vegetables, a knowledge of the various forms and appearances that are assumed by the calyx and the corolla, is indispensibly necessary. As this subject will be more particularly treated of in a future part of this work†, it is the less necessary to dwell upon it in this place.

In drawing the generic characters of vegetables, the different species of calyx and corolla are constantly attended to by Linnæus, and all other modern botanists. In many instances, these parts even afford excellent marks for the discrimination of the species.

Neither the calyx nor the corolla are ever essentially regarded by Linnæus in the classical or ordinal characters of his Sexual System. It is to be observed, however, that this illustrious naturalist has founded a method of plants exclusively upon the form and other circumstances of the calyx. To this method, which he publish-

* Philosophia Botanica, &c. p. 79, 80. § 119.

† See Part III.

ed in 1737, he has given the name of *methodus calycina*. The method of Magnol, a Professor, at Montpelier, can hardly be called a method founded on the calyx. Linnæus, however, mentions Magnol, along with himself, among the CALYCISTÆ, or those botanists who have founded their classes upon the calyx.

WITH respect to the corolla, many botanists have founded the classes, or primary divisions, of their systems, entirely upon the regularity, the figure, the number, and other circumstances of the petals. The most celebrated systems of this kind, are those of Augustus Quirinus Rivinus, and Joseph Pitton Tournefort.

THE method of Rivinus proceeds upon the circumstance of the regularity and the number of the petals. That of Tournefort is founded upon the figure and regularity of the petal. Both of these methods are now universally neglected. They have given way, in the revolutions of science, to the more difficult Sexual System of Linnæus. But genuine botanists will continue to regard, with some attention, the arrangements of these COROLLISTÆ, as Linnæus is pleased to denominate them*. System is a slippery thing. The time may again arrive, when the method of Tournefort will maintain a station, if not as elevated as it once did, at least much more elevated than it does at present. THE SEXUAL SYSTEM OF LINNÆUS CANNOT BE IMMORTAL. IT WILL, AT SOME FUTURE PERIOD, BE DESERTED FOR A SYSTEM MORE AGREEABLE TO THE SCHEME OR INTENTIONS, OF NATURE.

* Linnæus has given this name (which, it is evident, is derived from the word corolla), to those systematic botanists, who have distributed vegetables according to the regularity, the figure, and other circumstances, of the corolla. Some of the most eminent botanists have been *Corollistæ*.

§. III.

It has already been observed, that the corolla, according to Linnæus, consists of two parts, the Petal, and the Nectarium, or the Nectary*. Of this last-mentioned part I am now to give some account.

Linnæus defines the nectary "the melliferous part "of the vegetable, peculiar to the flower." According to our author, it secretes or contains a peculiar fluid, the honey of the plant, which constitutes the principal food of bees, and various other species of insects.

The Swedish naturalist assumes to himself the honour of having first recognized this part in the vegetable structure. "*Nectarium* (says he) ne nomine "notum erat, antequam idem determinavimus†." But it is certain, that both Tournefort and Sebastian Vaillant had noticed the nectary in certain species of plants; the first of these celebrated men before the birth of Linnæus, and the last when the Swede was not more than ten years old. In 1694, Tournefort observed the nectary in the Passion-flower, the Asclepias, or Swallow-wort, and some other plants; and in 1718, Vaillant, who was both a man of genius and an able botanist, noticed it, and regarded it as a part depending upon the corolla, or petals; but which did not, in his opinion, merit any particular appellation.

* See pages 127, 131.

† Philosophia Botanica, &c. p. 125. §. 181.

To the part of which I am speaking, the English writers have given different names. By some*, it has been called the "honey-cup." But this name cannot, with propriety, be applied to every species of nectarium, since, in many plants, this part bears no resemblance whatever to a cup, or vessel of any kind. To the term nectary, as a generic term equivalent to the Latin nectarium†, there is less objection, especially as the word nectar, applied to a sweet or honied liquor, is so familiar in the English language; as are also, the words "nectared," "nectareous," and "nectarine." Thus, in the following lines, the greatest of the English poets uses the word "nectared."

"How charming is divine philosophy!
"Not harsh and crabbed, as dull fools suppose,
"But musical as is Apollo's lute,
"And a perpetual feast of *nectar'd* sweets,
"Where no crude surfeit reigns."

MILTON.

a. THE nectary assumes a variety of forms, in different species of vegetables. Thus, 1. in many flowers, it is shaped like a horn, or the spur of a cock. This is the *nectarium calcaratum*, *corniculatum*, or *cornutum*, the spurred, spur-shaped, or horned nectary; of which we have examples in the following vegetables, viz. Valerian, Water-Milfoil, Butter-wort, Calves-snout, Lark-spur, Violet, Fumatory, Balsam, and Orchis. 2. The *nectarium scrotiforme*, or purse-like nectary, is somewhat globular, with a depressed line in the middle. 3. *nectarium ovatum*, or ovate nectary. 4. *nectarium tur-*

* Dr. Darwin, &c.

† "Those who prefer the Latin termination, use *nectaria* in the plural, "which is not English. Why do they not use *filamenta*, *stigmata*, &c?" Professor Martyn.

binatum, or turbinate nectary; and, 5. *nectarium carinatum*, or keeled nectary. This kind of nectary, being entirely distinct from the petals, is denominated *nectarium proprium*, or proper nectary.

b. In some plants, the nectary is really a part of the corolla, since it lies within the substance of the petals. The following plants are instances of this kind of nectary, viz. Fritillaria, Lilium, Swertia, Iris, Hermannia, Uvularia, Hydrophyllum, Myosurus, Ranunculus, Bromelia, Erythronium, Berberis, and the wonderful Vallisneria. This is what Linnæus calls *nectarium petallinum*, or petalline nectary.

c. In many plants, the nectary is placed in a series or row, within the petals, or corolla, and yet is entirely unconnected with their substance. A nectary of this kind is said, by Linnæus, to crown the corolla. The following plants, among many others, furnish examples of this kind of nectary, viz. Passiflora*, Narcissus, Pancratium, Olax, Lychnis, Silene, Stapelia, Asclepias, Cynanchum, Nepenthes, Cherleria, Clusia, Hamamelis, Diosma.

d. In the following plants, the nectary is situated upon, and makes a part of, the calyx, instead of the corolla: viz. Tropæolum, Monotropa, Biscutella, and Malpighia. This is the *nectarium calycinum*, or calycine nectary.

e. In some plants, the nectary is situated upon the anthers, or summits of the stamens. Hence one of these

* See Plate XXV.

plants, the Bastard flower-fence of the English, has received the generic name of Adenanthera.

f. The nectary of many plants is placed upon the filaments. This is the case in Laurus, Dictamnus, Zygophyllum, Commelina*, Mirabilis, Plumbago, Campanula, Roëlla, and others.

g. In the following plants, the nectary is placed upon the germ, or seed-bud: viz. Hyacinth, Flowering-Rush, Stock July-flower, and Rocket. This is the *nectarium pistillaceum*, or pistillaceous nectary.

h. In Honey-flower, Orpine, Buck-wheat, Collinsonia, or Horse-weed; Lathræa, Navel-wort, Mercury, Clutia, Kiggelaria, Sea-side Laurel, and several others, the nectary is placed upon, or attached to, the common receptacle. This is the *nectarium receptaculaceum*, or receptacular nectary.

i. Linnæus considers, as a true nectarium, the tube, or lower part, of the monopetalous or one-petalled flowers, such as Datura, Nicotiana, &c. because, in general, this part contains, and probably forms, a sweet or honied liquor, which constitutes one of the alimentary articles of bees, phalænæ, and other insects.

k. In many plants, such as Ginger, Turmerick, Reseda, Grewia, Nettle, Bastard Orpine, Vanilla, Willow, &c. the nectary is of a singular construction, and cannot, with propriety, be referred to any of the preceding heads.

* See Plate X. Fig. 1.

Linnæus affirms, that those plants which have their nectary distinct from the petals, that is, not lodged within the substance of the petals, are generally poisonous. The following plants are adduced as examples of this observation: viz. Monkshood, Hellebore, Columbine, Fennel-flower, Parnassia, Barren-wort, Oleander, Marvel of Peru, Bean-Caper, Succulent Swallow-wort, Fraxinella, and Honey-flower.

Some of these plants are, indeed, poisonous, such as Monkshood, Oleander, Hellebore, &c. But, I am inclined to think, that the observation of Linnæus is not of much practical importance; since it is certain, that some of the plants which he has introduced into the list are by no means highly deleterious; and their honey does not seem to contain any noxious quality. F. A. Cartheuser, a long time ago, denied the truth of the Linnæan position. S. A. Spielmann asserts, that there is nothing poisonous in the flowers of the Aconitum, or Monkshood*. Certain it is, that bees extract the honey of this plant, as they do also from the nectaries of Aquilegia vulgaris, and Aquilegia canadensis, or Common, and Canadian Columbine. It must, however, be admitted, that we cannot safely infer the innocent nature of a vegetable, because bees extract, and receive no injury from, the honey of such vegetable.

It has always appeared to me, that the Swedish naturalist has been less happy, and has discovered less talent and precision in his history of the nectary, than in his account of most of the other parts of the vegetable. Notwithstanding his assertion, that the nectary

* De Aconito. Argentorati: 1769. 8vo.

is a part of the corolla, it is certain, that all flowers are not provided with this organ or appendage, and in many plants which are provided with it, there is no immediate connection whatever between it and the corolla. "Linnæus (to use the words of a very sensible botanist) "might, with equal propriety, have termed it (the nec- "tary) a part or appendage of the stamina, calix, or poin- "tal, as the appearance in question is confined to no par- "ticular part of the flower, but is as various in point of "situation, as of form. The truth is, the term *nectarium* "is exceedingly vague; and, if any determinate mean- "ing can be affixed to it, is expressive of all the singu- "larities which are observed in the different parts of "flowers*."

Dr. Smith observes, that "Linnæus called every "thing, not calyx, petals, or organs of propagation, "*nectarium*†." It may be added, that what the Swedish naturalist calls nectaria, some other writers have thought proper to denominate petals. Thus, Vaillant denominated the nectaries of the Nigella and Aquilegia, petals. The coloured leaves of these plants, which are now regarded as petals, the French botanist called the calyx, or flower-cup. G. C. Oeder follows Vaillant, in considering the nectaries of many of the plants of the class *Polyandria*, as petals. Moenich calls these spurred or horned nectaries, of which I am speaking, *parapetala*. Linnæus has, moreover, sometimes called the abortive or infertile stamens of certain plants, nectaria. In this respect, Mr. L'Heritier has also erred, particularly in drawing the generic character of Erodium.

* Milne's Botanical Dictionary, &c. article Nectarium.

† Syllabus, &c. p. 23.

Upon the whole, the term nectarium is an extremely vague one. I cannot help agreeing with Mr. De Jussieu, that the term should be rejected from the science of Botany. It is greatly to be wished, that some person, possessed of the requisite talents, would undertake the investigation of the subject of the various species of nectaries, and arrange these parts under some more appropriate names.

Necker restricts the term nectarium, to those glandular bodies which occupy the base of the stamens, and secrete a honied liquor. He admits, that there are other parts of vegetables which furnish a honied liquor in flowers, but these, he says, are of no consequence in determining the characters of plants†.

In investigating the genera of plants, a knowledge of the various species of nectarium is of very essential, and indeed, indispensible, consequence. Thus, the essence of the genus Ranunculus, consists in its nectary, which is a small prominence that is situated at the unguis, or claw, of each petal of this plant. But this subject will be particularly attended to, in Part Third of this work.

* * * * * * * * *
* * * * *

The chemical analysis of the honey of the nectaries, has been very little attended to. What has been done, leads us to believe, that this secreted juice (in many plants at least), contains nothing distinct from su-

† Corollarium, &c. p. 13, 14.

gar or honey. F. A. Cartheuser examined the honey of the nectaria of different plants, particularly that of the Melianthus, or Honey-Flower. He says the honey of this plant is a true honey. Some authors inform us, that the honey of the Melianthus is a stomachic. This would seem to show, that it contains some foreign quality, distinct from mere sugar or honey.

THERE is often, however, combined with the honey of plants, a noxious property. This is frequently the property of the plant which secretes the honey. The tube of the flower of the Agave americana contains a great deal of a watery, honey-like fluid, which is sweet, and of an acid nature. This fluid is purgative, and emetic, when exhibited in the dose of two table-spoonfuls. The nectar of some plants is entirely refused by the bees. Thus, bees do not touch the honey of the Fritillaria, or Crown-Imperial*. Yet I do not know that any experiments have shown, that this honey is noxious to animals. The Fritillaria is, indeed, a poisonous plant. But we are told, that the Willow-wren runs up the stem of this fine vegetable, and sips the honey. We know that the honey which is procured from certain vegetables is poisonous. The Greek† and Roman‡ naturalists speak of a poisonous honey; and we are acquainted with some of the plants from which this honey is procured. In North-America, an intoxicating and deleterious honey is procured from the flowers of the Kalmia angustifolia, and other vegetables. In the *Transactions* of the American Philosophical Society**,

* J. Duverney, Linnæus, &c.

† Xenophon, Dioscorides, Diodorus Siculus, &c.

‡ Pliny. ** Vol. V. No. VII.

I have inserted a memoir on the "Poisonous and Injurious Honey of North-America." To this memoir I beg leave to refer the reader.

It has been observed, that the nectar of plants, "tempts insects to assist the impregnation*." This is, no doubt, the case. But it may well be questioned, whether this is the final end, or intention of nature, in furnishing plants with the nectary fluid. We find that the nectar of some plants is altogether untouched by insects. Such as Fritillaria. Besides, in very many plants, which abound in nectar, the styles, from their proportion, or situation, are readily, nay necessarily, impregnated, without any insectile assistance. In Fritillaria, the aid of insects cannot be wanted. I presume, that the business of vegetable impregnation would proceed very well, even were the whole world of insects entirely annihilated. So little *necessary* dependence, in this respect at least, is there between the great worlds of animals and vegetables. So feeble, so visionary, is the theory of those philosophers, who have imagined, that Nature has connected together, in necessary dependence, her innumerable productions, like links in a chain of man's construction!

The botanists have found no small difficulty in determining the real use of the nectaries, and of the honied liquor which they contain. Julius Pontedera imagined, that the honey of plants is equivalent to the *liquor amnii*, or liquor of the amnion, in pregnant animals, and that it enters the fertile or impregnated seeds†. Here it might

* Dr. I. E. Smith.

† Anthologia, seu de Floris Natura, &c. Patavii: 1720. 4to.

be observed, that the importance of the liquor amnii, as an agent in the nutrition of the fetus, is not admitted by the generality of the modern physiologists*. It is, however, of more importance, to observe, that the hypothesis of Pontedera is rendered improbable by this circumstance, that the nectary, and the honey which it contains, are found in many male flowers, such as those of the Willow and the Nettle, where there are no seeds to be impregnated. Perhaps, however, this does not decidedly show, that the nectareous fluid is useless in giving fertility to the seed. It is certain, that nature, intent upon a specific object, or end, sometimes bestows upon the different sexes of a species, the same organs. Thus, she concedes to the males and females of certain animals, the secretory organs, which we call mammae, or breasts. In both sexes, these organs sometimes secrete a peculiar fluid, called milk. Yet, this secretion can be required in one of the sexes only.

But actual experiments have shown, that the nectary is not essentially necessary to the fertility of the seed. We have seen, that in many plants, the nectaries are distinct from the corolla. The Aconitum, or Monkshood, is one of these plants. The nectaries of this plant were removed; but the seeds were as effectually ripened, as though the operation had not been performed†.

Ludwig supposed that the office of the nectary is to excrete those juices of the plant which are too thick, or

* Of late, however, Dr. Darwin has endeavoured to show, that the liquor amnii is of real importance, in the nutrition of the fetus. See his Zoonomia, &c. Vol. I. Sect. XXXVIII.

† F. A. Cartheuser.

gross*. But neither is this a very satisfactory explanation of the use of the organ.

Boehmer supposes, that the true nectaries secrete a juice which is necessary to the nutriment of the plant†.

Dr. Darwin has proposed a new and very ingenious idea concerning the use of the nectary of vegetables. "The nectary, or honey-cup, he says, is evidently an "appendage to the corol, and is the reservoir of the "honey, which is secreted by an appropriate gland from "the blood, after its oxygenation in the corol"——— "and is absorbed for nutriment by the sexual parts of "the flower." It is the opinion of this writer, that this saccharine secretion serves as food to the anthers, and stigmas. Let us see upon what grounds this idea proceeds. In many tribes of insects, as in the silk-worm, moths, butterflies, &c. the male and female parents die as soon as the eggs are impregnated and excluded, the eggs remaining to be perfected and hatched at some future period. In vegetables we observe nearly the same phenomenon. In this family of animated objects, the stamens and pistils fall off and die, as soon as the seeds are impregnated, and along with these genital parts, the petals and honey-cups. It is observed, that the insects which I have mentioned, so soon as they acquire the passion and the apparatus for the reproduction of their species, lose the power of feeding upon leaves, as they did before, and become nourished by honey alone.

"Hence (continues our author) we acquire a strong "analogy for the use of the nectary, or secretion of ho-

* Institutiones Regni Vegetabilis, &c. 1757. 8vo.

† Dissertatio Inauguralis de Nectariis Florum. Wittemberg: 1758. 4to.

" ney, in the vegetable economy; which is, that the male " parts of flowers, and the female parts, as soon as " they leave their fetus-state, expanding their petals " (which constitute their lungs*) become sensible to the " passion, and gain the apparatus, for the reproduction " of their species; and are fed and nourished with ho- " ney like the insects above described; and that hence " the nectary begins its office of producing honey, and " dies or ceases to produce honey, at the same time with " the birth and death of the anthers, and the stigmas; " which, whether existing in the same or in different " flowers, are separate and distinct animated beings.

" PREVIOUS to this time, the anthers with their fila- " ments, and the stigmas with their syles, are in their " fetus-state sustained in some plants by their umbilical " vessels, like the unexpanded leaf-buds, as in Colchicum " autumnale, and Daphne Mezereon; and in other plants " by the bractes, or floral-leaves, as in Rhubarb, which " are expanded long before the opening of the flower; the " seeds at the same time existing in the vegetable womb " yet unimpregnated, and the dust yet unripe in the cells " of the anthers. After this period, the petals become ex- " panded,"——" the umbilical vessels, which before " nourished the anthers and the stigmas, coalesce, or " cease to nourish them; and they acquire blood more " oxygenated by the air, obtain the passion and power " of reproduction, are sensible to heat, and light, and " moisture, and to mechanic stimulus, and become, in " reality, insects fed with honey; similar in every res- " pect except that all of them yet known but the male

* See page 140, 141.

" flowers of Vallisneria*, continue attached to the plant,
" on which they are produced.

" So water insects (continues our author), as the
" gnat, and amphibious animals, as the tad-pole, ac-
" quire new aerial lungs, when they leave their infant
" state for that of puberty. And the numerous tribes of
" caterpillars are fed upon the common juices of vege-
" tables found in their leaves, till they acquire the organs
" of reproduction; and then they feed on honey, all I be-
" lieve except the silk-worm, which in this country
" (Britain) takes no nourishment after it becomes a but-
" terfly. And the larva or maggot of the bee, accord-
" ing to the observations of Mr. Hunter, is fed with
" raw vegetable matter, called bee-bread, which is col-
" lected from the anthers of flowers, and laid up in cells
" for that purpose, till the maggot becomes a winged bee,
" acquires greater sensibility, and is fed with honey†."

Such is Dr. Darwin's hypothesis concerning the use of the nectar, or honied liquor of plants. The hypothesis is certainly ingenious, and is entitled to the attention of naturalists. But it is merely in the light of an hypothesis that it ought to be viewed. And yet it has already been adopted by some writers, particularly by the ingenious female author of a work entitled *Botanical Dialogues*‡. Future experiments will show how far the opinion of the English philosopher is founded upon a

* We are now acquainted with two species of Vallisneria, the V. spiralis, and V. Americana. Of this last species, which is a native of many parts of North-America, growing abundantly in the river Delaware, &c. &c. I have given a particular account, in a memoir read before the American Philosophical Society, on the 6th of February, 1801.

† Phytologia, &c. Sect. VII. See, also, Sect. VI

‡ London: 1797. 8vo.

solid basis. I must confess, that very powerful objections to the hypothesis present themselves to my mind. Certainly, all plants are not furnished with the organs called nectaries, particularly with those species of nectaries which are known to secrete or contain a honied fluid. Moreover, we have seen, that the nectaries of certain species of plants may be entirely removed, without obviously affecting, in any degree, the health or fertility of the plant. When we consider, however, the highly nutritious nature of sugar, honey, and other saccharine matters, it would seem not improbable, that the nectar is really conceded to plants to assist in giving nutriment or strength to them. This opinion is, at least, more philosophical, than that of those writers, who have imagined, that plants are furnished with nectar merely as an alimentary article for insects, or as an incitement for them to give their aid, in ensuring the fertility of plants.

§. IV.

The Stamen, which some English writers have called the Chive, is defined, by Linnæus, "an organ for the preparation of the pollen:" "Viscus pro Pollinis præparatione*."

The stamens, in most flowers, are placed round the seed-bud, and consist, according to Linnæus, of three parts, the *Filamentum*, the *Anthera*, and the *Pollen*. In reality, however, the stamen consists of only two parts, the filamentum, and the anther, the pollen being merely a matter secreted by, or contained in, the anther.

* Philosophia Botanica, &c. p. 53. §. 66

A. I SHALL first speak of the Filamentum. This, which receives its name from the Latin word, *filum*, a thread, is the more slender, or thread-like part of the stamen which supports the anther, and connects it with the flower. The term filament is equivalent to the term stamen, as employed by Tournefort, and other botanists.

a. THE filaments, in respect to number, are very different, in different vegetables. Some plants have but one filament, some two, three, &c. &c. whilst some have from twenty to a thousand.

b. IN point of figure, the filament is, 1. *capillare*, capillary; long and fine like a hair. 2. *planum*, flat; having the two surfaces parallel. 3. *cuneiforme*, cuneiform; or wedge-shaped. 4. *spirale*, spiral; ascending in a spiral line. 5. *subulatum*, subulate, or awl-shaped. 6. *emarginatum*, emarginate. 7. *reflexum*, reflected. 8. *laciniatum*, laciniated. 9. *dentatum*, toothed. 10. *mutilatum*, mutilated; with the rudiment only of a filament. 11. *castratum*, castrated; elevating a barren anther, or none at all; as in some species of Geranium.

c. IN point of insertion, the filaments are, 1. *calyci opposita*, opposite to the leaflets or segments of the calyx. 2. *calyci alterna*, alternate with the calyx; placed alternately with the leaflets of the calyx. 3. *corollina*, inserted into the corolla. 4. *calycina*, calycine; inserted into the calyx. 5. *receptaculacea*, receptacular; inserted into the receptacle. 6. *nectarina*, nectarine; inserted on the nectary. 7. *stylo inserta*; inserted on the style; as in the plants of the class *Gynandria*.

d. In point of proportion, the filaments are, 1. *æqualia*, equal; all of the same length. 2. *inæqualia*, unequal; some larger than others. 3. *connata*, connate; conjoined into one body, so as to form a tube at the base; as in the plants of the class *Monadelphia* 4. *longissima*, very long; longer than the corolla. 5. *brevissima*, very short; much shorter than the corolla. 6. *longitudine corollæ*, of the same length as the corolla. 7. *longitudine calycis*, of the same length as the calyx.

e. In respect to its surface, the filament is, 1. *pilosum*, hairy. 2. *villosum*, villous. 3. *hirsutum*, hirsute.

f. In respect to its structure, the filament is, 1. *membranaceum*, membranous. 2. *nectariferum*, nectariferous.

g. In respect to its direction, the filament is, 1. *erectum*, erect. 2. *patens*, spreading. 3. *patentiusculum*, somewhat spreading. 4. *patentissimum*, very much spreading. 5. *arcuatum*, bowed; bent in the form of a bow. 6. *connivens*, converging; approaching the other filaments with the point. 7. *reflexum*, reflected. 8. *declinatum*, declined. 9. *inflexum*, inflected. 10. *flaccidum*, flaccid. 11. *assurgens*, assurgent. 12. *ascendens*, ascending. 13. *recurvum*, recurved. 14. *incurvum*, incurved.

In assimilating the animal and the vegetable kingdoms, Linnæus has been pleased to denominate the filaments, "vasa spermatica," or the spermatic vessels. We shall afterwards have occasion to inquire, how far there is any foundation for this opinion; and, also, with

what propriety, the anthers are denominated the "testes" of the plant.

B. The Anther is the second part of the stamen. This is the part which Ray denominated the *Apex*, and Malpighi, *Capsula staminis*. Dr. Grew, and others of the older botanists, called it the Summit, Semet, Pendent, or Tip. "I prefer Anther to Anthera, in English; be- "cause we thus avoid any dissention between the learn- "ed and unlearned, respecting the pronunciation of the "penultima, and the formation of the plural*."

Linnæus defines the anther to be a part of the flower, big with pollen, or farina, which it emits or explodes when ripe†. The anther may be defined, a capsule or vessel, destined to produce or contain a substance whose office is the impregnation of the germ, or female organ. It commonly forms a part of the stamen, and is usually placed upon the top of the filament. But it must not be forgotten, that in many plants, the anther exists without any filament to support it.

a. The number of the anthers is very different in different plants. The generality of plants have a single anther to each filament. This is the case with most of the plants that are figured in these *Elements*. To this general rule, however, there are many exceptions: viz. 1. Mercurialis, or Mercury, and Ranunculus have two anthers to each filament. This is what Linnæus denominates, *anthera didyma*, or twin anther. 2. Fumaria has

* Professor Martyn.

† "*Anthera* pars floris gravida Polline, quod matura dimittit." Philosophia Botanica, &c. p. 53. §. 86.

three anthers to each filament. 3. Bryonia has five anthers to three filaments. Here a single anther is affixed to one of the filaments, and the remaining four anthers are equally divided between the other two filaments. 4. In the Theobroma, or Chocolate-nut, there are five anthers to each filament. 5. The Pea, the Bean, Vetch, Trefoil, Liquorice, and many other flowers of the class of *Diadelphia*, have, in general, ten anthers to two filaments; or, more properly speaking, to two sets of united stamens. 6. In the Cucurbita, or Gourd, there is one anther common to three filaments. 7. In the Dandelion, Feverfew, Groundsel, and other really compound flowers, of the class of *Syngenesia*, one anther is common to five filaments: or, to speak more properly, five anthers, which are united into a cylinder, are placed upon five distinct and separate filaments. 8. In some plants, some of the filaments are terminated by anthers, whilst others are naked, or destitute of these parts. Thus, the two genera Chelone and Martynia, are furnished with four complete stamens; together with the rudiment of a fifth filament, which is destitute of the anther. Verbena has four filaments, only two of which are antheriferous. The Bignonia Catalpa of Linnæus has two perfect stamens, or stamens with anthers; and three filaments, which want the anthers. Other irregularities of this kind will be noticed, in the progress of this work.

b. In point of figure, the anther is, 1. *oblonga*, oblong. 2. *globosa*, globular. 3. *sagittata*, sagittate. 4. *angulata*, angular. 5. *cornuta*, horned. 6. *bicornis*, two-horned. 7. *linearis*, linear. 8. *acuta*, acute. 9. *acutiuscula*, rather acute. 10. *cordata*, cordate. 11. *ovata*, ovate. 12. *hastata*, hastate. 13. *biloba*, two-lobed. 14. *reniformis*, reniform. 15. *bifida*, bifid. 16. *bipartita*,

two-parted. 17. *aristata*, awned; ending in an awn. 18. *setifer*, bristle-bearing; ending in a bristle. 19. *rostrata*, rostrate, or beaked; ending in a filiform beak. 20. *truncata*, truncated. 21. *obtusa*, obtuse. 22. *emarginata*, emarginate. 23. *acuminata*, acuminate. 24. *furcata*, forked; divided at the end, and diverging.

c. In point of direction, the anther is, 1. *erecta*, erect. 2. *rigida*, rigid. 3. *patens*, spreading. 4. *assurgens*, assurgent. 5. *inflexa*, inflected. 6. *nutans*, nodding. 7. *declinata*, declined. 8. *pendula*, pendulous. 9. *incurva*, incurved. 10. *connivens*, converging. 11. *spiraliter contorta*, twisted spirally.

d. In point of insertion, the anther is, 1. *sessilis*, sessile. 2. *versatilis*, versatile; incumbent, but freely moveable. 3. *adnata*, adnate. 4. *distincta*, distinct; not cohering with other anthers. 5. *connatæ*, connate; when several anthers are conjoined into one. 6. *cylindraceæ*, cylindrical; formed into a cylinder, or equal tube. 7. *tubulatæ*, tubular; coalescing so as to form a tube; as in the compound flowers of the class of *Syngenesia*. 8. *cohærentes*, cohering at the base, apex, &c. 9. *incumbens*, incumbent; fixed by the middle upon the filament. 10. *lateralis*, lateral; connected by the whole side to the filament.

e. In respect to substance, the anther is, 1. *membranacea*, membranous. 2. *depressa*, depressed. 3. *compressa*, compressed. 4. *convexa*, convex. 5. *plana*, flat. 6. *sulcata*, furrowed. 7. *transversim sulcata*, transversely furrowed. 8. *longitudinaliter sulcata*, longitudinally furrowed. 9. *subulata*, subulate. 10. *bilamellata*, bilamellated; with two membranous plates.

f. In respect to measure, the anther is, 1. *filamentis brevior*, shorter than the filaments. 2. *corolla brevior*, shorter than the corolla. 3. *longitudine filamenti*, of the same length as the filament. 4. *longior filamentis*, longer than the filaments. 5. *æquales*, equal; of the same size as one another. 6. *longissima*, very long; much longer than the filament. 7. *brevissima*, very short; much shorter than the filament.

g. In respect to its place, the anther is, 1. *tecta*, covered; concealed by a scale of the arch, as in the *Asperifoliæ*, or Rough-leaved plants. 2. *inclusa*, enclosed; situated within the throat of the corolla. 3. *nuda*, naked; neither covered nor enclosed.

h. In respect to its cells and aperture, the anther is, 1. *unilocularis*, one-celled. 2. *bilocularis*, two-celled. 3. *trilocularis*, three-celled. 4. *bivalvis*, two-valved. 5. *didyma*, didymous; gibbous outwardly, with two protuberances. 6. *sterilis*, barren; not forming pollen, or fecundating matter. 7. *deflorata*, deflorate; having ejected, or excluded the pollen. 8. *fœcunda*, fertile, with pollen. 9. *apice dehiscens*, opening at the top. 10. *latere dehiscens*, opening at the side.

Linnæus denominates the bursting of the anthers, *Dehiscentia**.

i. In respect to situation, 1. the anthers are generally situated upon the tops of the filaments. 2. In some plants, however, the anthers are fixed to the middle or sides of the filaments. 3. In many plants, having no filaments, the anthers adhere to the stigma, or summit of

* *Dehiscentia*, from *dehisco*, to gape, or open wide.

the female organ. 4. In other plants, also destitute of filaments, the anthers are fixed to the receptacle. 5. In some, they are situated upon the nectary.

C. The Pollen, which Linnæus is pleased to call the third part of the stamen, is the farina, or prolific powder, which is contained in the anthers of flowers, and which, according to the Swedish naturalist, after being moistened with a liquor which is peculiar to, and lodged upon, the stigma, or summit of the female organ, bursts like a bladder, and gives out, elastically, a substance which is imperceptible to the naked eye. This substance Linnæus calls *Fovilla*, or *aura seminalis*.

Necker defines the pollen, a collection of minute inflammable globules, in which the "lympha fœcundans," or fecundating fluid, is contained*. The pollen of some plants, is, certainly, inflammable; but in the pollen of many other plants we discover nothing of an inflammable quality. In many plants, such as Veratrum luteum†, &c. the pollen has a peculiar and powerful smell, very similar to that of certain animal secretions.

The pollen of vegetables is of various colours, but most commonly of the different shades of yellow, orange, red, and purple. It is beautifully conspicuous upon the anthers, or summits, of some flowers, particularly the Tulip, the Lily, &c. When completely matured, and fit for performing the important office, for which it is destined, it is readily removed from the anthers, by the application of the finger, or other moist body.

* Corollarium, &c. p. 14. † Melanthium dioicum ? of Walter.

To the naked or unarmed eye, the pollen appears to be a mere inorganic farina, or powder. But when it is subjected to the aid of the microscope, it is found to put on a great variety of forms, in different species of vegetables. These forms, it is asserted, frequently predominate, not only through the different species of a genus, but even through the different genera of a natural family, or order. Thus, in Helianthus, or Sunflower, the polleniferous particles assume the appearance of prickly balls, or burs. In the Geranium sanguineum, or Bloody Cranesbill, they are like perforated globules of fire; in the Mallows, they resemble wheels furnished with teeth; in the Ricinus communis, or Palma Christi, they are shaped like grains of Wheat; in the Viola tricolor, or Pansies, they are angulated; in the Turkey-Wheat*, they are flat and smooth; in the Borage, like a thin leaf, rolled up; in the Narcissus, reniform, or kidney-shaped; and in the Symphitum, or Comfrey, like double or twin globules†. It is unnecessary to pursue this subject through numerous other vegetables, the pollen of which has been particularly examined, through good glasses, by many ingenious naturalists.

Tuberville Needham, and other writers have shown, that the pollen of vegetables upon being put into water, immediately bursts, and scatters its fovilla, or fecundating aura, abroad.

The great importance of the pollen, which Linnæus has called the "genitura" of the plant," will be very particularly considered, in treating of the generation of vegetables.

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* Zea Mays, or Indian-corn. † J. G. Wahlbom

As the nectar of vegetables is an article of great importance in the nourishment of bees and other insects, so also the powder of the anthers constitutes one of the alimentary articles of bees. These industrious insects visit the flowers of an immense variety of plants, quaffing the nectar, and carrying away, upon their thighs, great quantities of the pollen. This they lay up, in the cells of their combs, as food for the young bees, whilst in their larva, or maggot-state. To the pollen, thus stored up, the name of "bee-bread" has been given, both in Britain and in the United-States. This, as has been already observed*, is "raw vegetable matter," or pollen so little altered that it retains its peculiar taste and smell, in the cells of the comb. Thus, we can often tell, by an examination of the bee-bread, from what particular species of plants it has been procured. By thus depriving vegetables of their pollen, there can be little doubt that bees, in many instances, essentially diminish the fertility of plants†. This, perhaps, is more especially the case with respect to many of the plants of the class *Dioecia:* for here, the male and female organs of generation being situated upon distinct individuals, and frequently at a considerable distance from each other, the chances of impregnation are necessarily fewer than in the plants of the hermaphrodite classes, where the males and females are situated, in close vicinity, within the same calyx, or corolla. On the other hand, however, it is the opinion of many writers, that bees are no mean agents in fa-

* See page 157.

† It has been observed, in Pennsylvania, and other parts of the United-States, that the bees rob certain species of plants, particularly the Polygonum Fagopyrum, or Buck-wheat, of such immense quantities of pollen, that great numbers of the little insects are drowned in crossing our creeks, and rivers, owing to the too heavy loads of the powder, which they attempt to carry to their hives

vouring the impregnation of vegetables. We shall afterwards see, that the naturalists of the school of Linnæus have frequently been under the *necessity* of availing themselves of the agency of bees, to explain some of the difficulties which still obstruct the beautiful doctrine of vegetable generation*.

By robbing plants of their pollen, do not bees contribute not a little to that vast variety of double blossoms, with which our gardens are stocked and beautified? Some facts, and some plausible reasoning, might be urged in support of this conjecture.

To the pollen of vegetables and the labours of the bees mankind are indebted for a very important article, I mean wax, or bees-wax. The celebrated R. A. F. de Reaumur, a long time ago†, asserted, that the pollen of vegetables, after undergoing the digestive process in the stomach of the bee, was converted into wax. This opinion has lately been confirmed by the inquiries of Mr. John Hunter‡.

With respect to the analysis of the pollen and of wax, much still remains to be done by the chemists to complete this subject. Experiments, however, seem to render it probable, that the basis of both of these matters is a fat oil, which, combining with oxygen, passes to the state of a resin. If the nitric or muriatic acids be digested, for a considerable time, upon a fixed oil, this passes to the state of a matter intimately resem-

* See Part III.

† In the year 1740.

‡ Philosophical Transactions, for the year 1792.

bling wax. It remains to be proved, what is the precise nature of the matter by which the pollen is converted into wax, in the stomach of the bee.

Experiments will, in all probability, show, that the pollen of plants (of many plants, at least) contains a very large portion of oxygen. An anonymous author*, many years ago, asserted, that the pollen of plants (by giving out its phlogiston, as he supposed) brought the calx of iron to the state of a metal.

Tingry discovered, that the pollen contains volatile oils, and different essential oils, that are soluble in spirit of wine.

The powerful odour and the taste of the pollen of many plants would lead us to believe, that this prolific matter possesses very active qualities, with respect to the human and other animal bodies; and it is not improbable, that it might be advantageously employed in the treatment of some of our diseases. If I do not greatly mistake, the pollen of some of the *cerealia* is employed as a medicine, in certain diseases, in some parts of Poland.

In the study of Botany, it is a point of the utmost importance to be intimately acquainted with every circumstance relative to the stamens, by which I mean the male organs, taken in the aggregate, and consisting of the filaments, the anthers, and the pollen. Without an intimate acquaintance with the natural history of these truly important parts in the vegetable economy, we shall

* See Bibliotheca Botanica, &c. Auctore A. Hallero. Tom. ii. p. 189

be incapable of understanding that wonderful function, by which the world of vegetables has been thus far preserved from destruction; and by which it will, doubtless, be perpetuated (with the occasional loss of some species, in future, as heretofore, so long as our globe shall exist), to serve as the sustenance of man and other animals, and for innumerable other purposes. Nor does the utility of an acquaintance with the stamens terminate here. Upon these organs of the vegetable, the great Linnæus has constructed the most essential parts of his SEXUAL SYSTEM: the classes, or primary divisions, and many of the orders, or secondary divisions. The twenty-four classes of this celebrated system, are founded upon the circumstances of the number, the place of insertion, the proportion, the connection, the disposition, or the absence, of the stamens. Hence, it is obvious, that we cannot understand the system of the Swedish naturalist, without a thorough acquaintance with the sexual organs*.

§. V.

THE Pistillum is the fourth part of the fructification enumerated by Linnæus. He defines it, "a viscus or "organ adhering to the fruit, for the reception of the "pollen:" "Viscus fructui adhærens pro Pollinis re-"ceptione†".

THE pistillum, to which the English botanists have given the name of Pistil and Pointal, is the female part of the vegetable, which assumes the appearance of a

* See Part II. for a particular investigation of the physiology of the stamens; and Part III. for an exposition of the Linnæan System.

† Philosophia Botanica, &c. p. 53. §. 86.

column, or set of columns, and is commonly situated in the centre of the flower, within the stamens. When perfect, it consists of three parts, the *Germen*, the *Stylus*, and the *Stigma*.

A. The Germen, which is called by the English botanists the Germ, Ovary, or Seed-bud, is the rudiment of the fruit, yet in an embryo-state. It constitutes the lower part, or base of the pistil, and supports the style and the stigma.

a. The germ varies in respect to number in different plants. Some plants have but one germ, some two, three, &c. &c. whilst some have many.

b. In point of figure, the germ is, 1. *subrotundum*, roundish. 2. *ovatum*, ovate. 3. *oblongum*, oblong. 4. *turbinatum*, turbinate. 5. *conicum*, conical; in the form of a cone. 6. *lineare*, linear. 7. *cordatum*, cordate. 8. *obcordatum*, obcordate. 9. *globosum*, globular. 10. *fissum*, cleft. 11. *bifidum*, bifid. 12. *trifidum*, trifid. 13. *partitum*, parted. 14. *bipartitum*, two-parted. 15. *angulatum*, angular. 16. *triangulare*, triangular. 17. *didymum*, didymous. 18. *compressum*, compressed. 19. *acutum*, acute. 20. *rostratum*, beaked. 21. *subulatum*, subulate.

c. In respect to its surface, the germ is, 1. *scabrum*, rough. 2. *villosum*, villous. 3. *imbricatum*, imbricated.

d. In regard to its place, the germ is, 1. *superum*, superior; that is, included in the corolla, or the calyx.

2. *inferum*, inferior; placed beneath the corolla, or the calyx*.

e. In respect to its insertion, the germ is, 1. *sessile*, sessile. 2. *pedicellatum*, pedicelled; standing on a pedicel, or footstalk. 3. *setæ insidens*, sitting on a bristle.

f. In regard to its measure, the germ is 1. *minimum*, very small in proportion to the corolla. 2. *longitudine staminum*, as long as the stamens. 3. *longitudine calycis*, as long as the calyx. 4. *longitudine nectarii*, as long as the nectary.

Pursuing his favourite subject of the analogies which subsist between animals and vegetables, Linnæus has denominated the germ, the ovarium, or uterus of plants. To this language, I shall offer no objection. We shall afterwards see, that in the germ are contained the embryo-seed of the plant, which pre-exist in this organ (as do the ova in the ovaria of many, if not all, animals), and after receiving the influence of the pollen, or powder of the stamens, are rendered fertile, and thus befitted for the important business of the perpetuation of the species.

B. The Stylus†, or Style, is the middle portion of the pistil, which, in many plants, connects the stigma with the germ. I say, in many plants, for the style is not present in all plants, and is not essentially necessary to the generation of the plant. In this respect, it is upon a footing with the filament.

* See page 137.

† Stylus, from στυλος, a column.

a. The style, as well as the germ, varies in respect to number, in different plants. Some plants have but one style, some two, three, &c. &c. whilst some are furnished with many, of these organs. In general, the number of the styles is equal to that of the germs, or ovaries, each germ being furnished with its particular style. This is the structure of the compound flowers, the cone-bearing plants, the Rose, the Ranunculus, the Liriodendron, or Tulip-tree, and many others. 1. To this general rule, however, there are exceptions; that is, there are vegetables, which have more than one style to a single germ, or seed-bud. 2. There are other plants, such as the *Asperifoliæ*, and most of the Lip-flowers, which have a single style common to many germs. 3. In other plants, again, the style, at its origin, is single, but soon branches out into as many ramifications, as there are divisions, or cells, in the cavity of the germ. We discover this structure in the plants of the two families of Geranium and Mallow, and many of their relations, principally belonging to the class *Monadelphia* of the Sexual System.

b. In point of proportion, the style is, 1. *longissimus*, very long, with respect to the stamens. 2. *brevissimus*, very short. 3. *longitudine staminum*, as long as the stamens. 4. *crassitie staminum*, as thick as the stamens. 5. *crassus*, thick with respect to the stamens. 6. *tenuis*, slender with respect to the stamens.

c. In respect to its division, the style is, 1. *simplex*, simple; not divided. 2. *bifidus*, bifid. 3. *trifidus*, trifid. 4. *bipartitus*, two parted.

d. In respect to its figure, the style is, 1. *teres*, columnar. 2. *cylindricus*, cylindrical. 3. *capillaris*,

capillary. 4. *clavatus*, club-shaped. 5. *subulatus*, subulate. 6. *alatus*, winged. 7. *tetragonus*, four-cornered. 8. *ensiformis*, ensiform. 9. *pubescens*, pubescent; covered with pubescence. 10. *villosus*, villous.

e. In respect to its direction, the style assumes most if not all the directions which have been noticed in treating of the filaments*.

f. In respect to its situation, 1. the style, in the greater number of plants, is *in apice germinis*, placed on the top of the germ. 2. *ad latus germinis*, at the side of the germ: that is, the styles, which are numerous, proceed from within the side of their corresponding germs. This structure is observable in the Rose, the Raspberry, the Strawberry, the Cinquefoil, the Tormentil, and other plants belonging to the order *Polygynia* in the XIIth class, or *Icosandria*, of the sexual system.

g. In point of duration, the style is, 1. *persistens*, permanent; remaining until the fruit be ripe; as in the plants of the class *Tetradynamia*. 2. *deciduus*, deciduous; falling off with the other parts of the flower; as in the greater number of vegetables.

We have seen, that Linnæus denominates the germ, the ovarium, or uterus of plants. With respect to the style, he has been pleased to call this part, the vagina or fallopian tube†. If it could be demonstrated, that

* See page 160. *g*.

† "Filamenta *Vasa Spermatica*; antherae *Testes*, pollen *Genitura*, "stigma *Vulva*, stylus *Vagina*, germen *Ovarium*," &c. Philosophia Botanica, &c. p. 92. §. 146.

the style, in *all* plants, is really tubular, or hollow, there would, I think, be but one serious objection to the employment of the word vagina, in the manner it is applied by Linnæus. And it must be confessed, that in very many plants the style is unequivocally tubular: that is, there is an open or uninterrupted cavity leading from the stigma (which is next to be considered) to the ovary, or germ. In many other plants, however, no such duct has been discovered, even when the style has been examined by a powerful magnifier. But it does not follow from hence, that no such duct does exist. It may be too small to fall under the cognizance of our senses; or it may be visible only at a particular period, viz. when the stigma has received the influence of the pollen; or, in other words, at the moment of impregnation. Linnæus has shown, that in many plants the stigma is dilated at the moment it receives the pollen; but afterwards closes, so that no cavity is to be perceived. In treating of the generation and of the irritability of plants*, I shall resume the consideration of this subject. Meanwhile, I must not pass by unnoticed the observation of Linnæus†, respecting the Gratiola, or Hedge-hyssop. "Gratiola, œstro venereo agitata, pistillum stigmate hiat, rapacis instar draconis, nil nisi masculinum pulverem affectans; at satiata rictum claudit," &c.

C. The Stigma is the third and last portion of the pistillum. It is the summit or top of this female part of the plant, and is destined to receive the influence of the pollen, and transmit it to the germ. In the Latin

* See Part II.

† See the admirable paper, entitled *Sponsalia Plantarum*, p. 90, in the first vol. of the Amoenitates Academicæ.

language, the word *stigma* has several significations, none of which are agreeable to the senses in which it is employed by Linnæus. I wonder, with Professor Martyn, why the Swede did not make use of the more classical and appropriate word, *fibula**. Dr. Grew called the stigma, the knob, or button; and Dr. Withering the Summit.

a. The number of the stigmas is very different in different vegetables. Some plants have only one stigma; some two, some three, some four, some five, &c.

b. In respect to division, the stigma is, 1. *simplex*, simple. 2. *fissum*, cleft. 3. *bifidum*, two-cleft. 4. *trifidum*, three-cleft, &c. &c. 5. *partitum*, parted. 6. *bipartitum*, two-parted, &c. 7. *lobatum*, lobed. 8. *bilobum*, two-lobed, &c. &c.

c. In respect to figure, the stigma is, 1. *capitatum*, capitate; approaching in its form, at the top, to the shape of a globe. 2. *globosum*, globular. 3. *urceolatum*, urceolate; pitcher-shaped. 4. *ovatum*, ovate. 5. *obtusum*, obtuse. 6. *truncatum*, truncated. 7. *oblique depressum*, obliquely depressed. 8. *emarginatum*, emarginate. 9. *planum*, flat. 10. *reniforme*, reniform. 11. *orbiculatum*, orbicular. 12. *peltatum*, peltate †. 13. *coroniforme*, crown-shaped. 14. *cruciforme*, cruciform; in the form of a cross. 15. *stellatum*, stellate. 16. *canaliculatum*, channelled. 17. *concavum*, concave. 18. *umbilicatum*, umbilicate; concave, and orbicular. 19. *plicatum*, plaited. 20. *radiatum*, radi-

* *Fibula*, a button, a clasp, a buckle, &c.&c.

† See Plate 1.

ate; marked with striated rays, which diverge from the centre. 21. *angulatum*, angular. 22. *striatum*, striated. 23. *plumosum*, feathery. 24. *pubescens*, pubescent. 25. *filiforme*, filiform. 26. *capillare*, capillary. 27. *convolutum*, convolute. 28. *revolutum*, revolute. 29. *flexum sinistrorsum*, bent to the left. 30. *flexum dextrorsum*, bent to the right. 31. *barbatum*, bearded. 32. *imberbe*, beardless.

d. In respect to measure, the stigma is, 1. *longitudine styli*, as long as the style, &c.

e. In respect to expansion, the stigma is, 1. *fimbriato-crispum*, fimbriate-curled, or fringed. 2. *foliaceum*, foliaceous, or like a leaf. 3. *cucullatum*, cowled.

f. In respect to its duration, the stigma is, 1. *persistens*, permanent; remaining until the fruit be mature; as in Sarracenia*, Podophyllum†, and others. 2. *marcescens*, shrivelling, remaining, but becoming withered; as in the greater number of plants.

I have already ‡ mentioned the analogical name by which Linnæus has thought proper to designate the stigma. For that name there is, I think, as much, and even more, foundation, than for some others which the burning imagination of the northern naturalist has imposed, not only upon the *organa sexualia*, but upon other parts of the plant. It is, perhaps, to be regretted, that Linnæus so frequently indulges in the use of terms which might, without any real injury to his writ-

* See Plate I. † See Plate XVIII.
‡ See page 174. Note.

ings, have been dispensed with. It would have been well had he recollected the words of Cicero, "Nihil "obscœnum, nihil turpe dictu". But Philosophy must not be too squeamish; and when I read the least chaste writings of Linnæus, I will not say with the poet:

> "No pardon vile obscenity should find,
> "Though wit and art conspire to move your mind".
>
> POPE.

A KNOWLEDGE of the pistil, by which I mean the female organ, taken in the aggregate, as consisting of the germ, the style, and the stigma, is of no less consequence in the study of Botany, than is a knowledge of the stamens. In a physiological point of view, each set of these sexual organs is entitled to an equal portion of our attention. They are equally concerned in the business of the perpetuation of the species. The pollen of the anthers would have been secreted or formed in vain, were there no stigma, or germen to receive and preserve its vivifick influence.

As the classes, or primary divisions, of the sexual system of Linnæus, are founded upon the stamens, or male organs of generation, so many of the orders, or secondary divisions, are founded upon the pistils, or female organs, which I have been considering. All the orders of the first thirteen classes of this system are constructed exclusively upon the circumstance of the number of the pistils. This circumstance will necessarily claim our attention in the third part of these *Elements;* as will, likewise, the importance of the pistil as a generic and even specifick feature, in the description of vegetables.

§. VI.

The Pericarpium * is the fifth part of the fructification enumerated by Linnæus. He defines it "a "viscus, or organ, gravid (big) with seeds (that is a "vessel producing seeds), which it lets drop, when "they are ripe". "Viscus gravidum seminibus, quæ "matura dimittit†". He has also called it the "Ova- "rium fœcundatum‡", or "impregnated germ or "ovary".

By the English botanists, it is denominated, the Pericarp, Seed-vessel, or Seed-case. Each of these terms may be employed; for each is just and significant. I shall however more generally make use of the word pericarp, as being most agreeable to the prevailing English botanical nomenclature which is adopted in these *Elements*. Dr. Johnson's definition of the word, in his *Dictionary*, is extremely lame, and exceptionable. He says the pericarp is "a pellicle or thin mem- "brane encompassing the fruit or grain of a plant, or "that part of a fruit that envelopes the seed".

The pericarp is the developed germ, ovary, or seed-bud: that is, the germ fecundated, swollen, and arrived at maturity, after having received the influence of the pollen, or fecundating powder. Linnæus has, therefore, very properly compared this part of the fructification to the fecundated ovary in animals. It is certain, that, in general, the vegetable germ is not evolved

* From περ., around or about, and καρπος, fruit, or seed.

† Philosophia Botanica, &c. p. 53. §. 86.

‡ Ibid. p. 92. §. 146. "Pericarpium *Ovarium fœcundatum*, unde ova producit fœcunda".

into a *true* pericarp, if the pollen has been prevented from having access to the stigma*.

The pericarp is an organ of great importance. Hence, like all the truly important parts of vegetables, and of animals, it is very generally present. Its use is obvious; to keep and preserve the seeds until they are ripe; to serve as "the guard of the seed†", and then to commit them to the bosom of the earth, or to the air, and waters.

Some plants are destitute of the pericarp. This is the case in the Asperifoliæ, or Rough-leaved plants, in the Verticillate plants, and in the Compound-flowers. In these families of vegetables, the place of the pericarp is supplied by the calyx, which encloses the seed, and accompanies them to perfection‡; or by the receptacle, of which I am afterwards to speak more particularly. I cannot pretend to state, in this place, the proportion of plants that are destitute of the pericarp, compared to those which are furnished with this viscus. It may, however, be proper to observe, that the compound-flowers form a very extensive family, in most countries (particularly, perhaps, in North-America); and that many of the genera belonging to the other orders which I have mentioned, embrace a great number of species.

Linnæus enumerates eight different species of pericarp, viz. 1. the *Capsula*, 2. the *Siliqua*, 3. the *Legumen*, 4. the *Folliculus*, 5. the *Drupa*, 6. the *Pomum*, 7. the *Bacca*, and, 8. the *Strobilus*.

* See Part II. † Mr. John Ray. ‡ See page 125.

1. The Capsula*, or first species of pericarp which I have mentioned, is called by the English botanists, Capsule, little chest, or casket. It is a membranaceous, hollow pericarp, which spontaneously opens or splits in some determinate manner, or differently in different vegetables: "Pericarpium cavum, de-"terminate dehiscens†". Dr. Grew distinguishes all the dry seed-vessels, whether they be capsules (in the Linnæan sense of the word) or pods, by the name of "seed-cases", or "membranous uteri", in opposition to the pericarps of a pulpy kind, such as the fruit of the Apple, the Quince, the Cherry, the Gooseberry, and others; these last he nominates fruits. This distinction of the great English philosophical naturalist is more agreeable to the prevailing ideas with regard to all the various kinds of pericarp, than the distinction of Linnæus, and the botanists of his school. Nevertheless, the term pericarp, as a generic term, may, with great propriety, be employed.

a. In respect to its figure and substance, the capsula is, 1. *turbinata*, turbinate. 2. *inflata*, inflated. 3. *globosa*, globular. 4. *didyma*, twin, or didymous. 5. *scrotiformis*, purse-like; elevated with two protuberances. 6. *cylindracea*, cylindrical. 7. *columnaris*, columnar; cylindrical and capitate. 8. *ovata*, ovate. 9. *subrotunda*, roundish. 10. *oblonga*, oblong. 11. *obcordata*, obcordate; inversely cordate. 12. *obtusa*, obtuse. 13. *acuminata*, acuminate. 14. *ventricosa*, ventricose; oblong and very convex. 15. *compressa*, compressed. 16. *membranacea*, membranous. 17. *elastica*,

* Capsula, in Latin, signifies, a little coffer, or chest, or casket.

† Philosophia Botanica, &c. p. 53 §. 86.

elastic. 18. *triquetra*, triquetrous. 19. *tetragona*, four-cornered*. 20. *trisulca*, three-furrowed. 21. *triloba*, three-lobed. 22. *quinquedendata*, five-toothed. 23. *coronata*, crowned; the extremity furnished with leaflets, digested into a crown. 24. *circumscissa*, cut round; or bursting all round horizontally, like a snuff-box; as in Anagallis. 25. *articulata*, jointed; intercepted by joints. 26. *coriacea*, coriaceous; resembling leather; as in Æsculus†. 27. *carnosa*, fleshy; resembling flesh; as in Pontederia. 28. *lignosa*, woody; of a woody texture; as in Cedrela.

Capsules, in splitting or opening, are divided externally into one or more pieces, to which Linnæus has given the name of *Valvæ* and *Valvulæ*‡, or Valves. The valve is the outer coat, shell, or covering of a capsule, or any other species of pericarp, or the several pieces which compose it. It is rather the door, or opening, by which the seeds of the capsule are to go out, or escape.

According to the number of its valves, the capsule is, 1. *bivalvis*, bivalve, or two-valved; splitting into two parts or pieces; as in Celandine, and in all the siliques and legumes. 2. *trivalvis*, trivalve, or three-valved; opening with three valves; as in Violet, Æsculus, Cistus Helianthemum, and others. 3. *quadrivalvis*, quadrivalve; or four-valved; opening with four valves; as in Ludvigia, Oenothera, &c. 4. *quinquevalvis*, quinquevalve, or five-valved; opening with five

* See Plate x. † See Plate xv. d. e.

‡ From the Latin *valvæ*, doors or gates, which open and shut on both sides; folding-doors. Linnæus does not make any distinction between valva and valvula.

valves, as in Hottonia, Flax, Lime-tree (Tilia), Syrian-Mallow (Hibiscus), and Cotton (Gossypium).

The internal divisions of the capsule are denominated *Loculamenta**, or Cells. Thes eare the chambers appropriated for the reception of the seeds. According to the number of these cells, the capsule is, 1. *unilocularis*, unilocular, or one-celled; as in the Primrose. 2. *bilocularis*, bilocular, or two-celled; as in the Henbane, Tobacco, and Thorn-apple, or James-town-weed. 3. *trilocularis*, trilocular, or three-celled; as in the Lily, the Hyacinth, &c. 4. *multilocularis*, multilocular, or many-celled; as in the different kinds of Nymphæa and Nelumbium, which are known by the names of Water Lily.

The capsule has received different names, according to the number of the seeds which it contains. Thus, we have, 1. *capsula dicocca*, a dicoccous or two-grained capsule; consisting of two cohering grains or cells, with one seed in each. 2. *tricocca*, tricoccous or three-grained; swelling out in three protuberances, internally divided into three cells, with one seed in each; as in the genus Euphorbia, or Spurge. 3. *pentacocca*, pentacoccous, or five-grained; swelling out in five protuberances, or having five united cells, each containing one seed.

The partitions by which the capsule is internally divided into cells, are called by Linnæus *Dissepimenta*; each of these partitions, *dissepimentum*: "a wall separating a pericarp internally into cells". Dr. Martyn

* *Loculamentum*, in Latin, signifies a case, a drawer, a bag, &c..

calls this part of the plant, the partition: but I think it better to use the word Dissepiment.

The dissepiment is either, 1. parallel, *dissepimentum parallelum*, or, 2. contrary*. The former approaches in breadth and its transverse diameter to the valves; as in Lunaria and Draba. The latter is narrower than the valves; or, as Linnæus more fully expresses it in the *Delineatio Plantæ*, narrower, when the valves, by being queezed or contracted, become concave. ("Angustius ubi valvulæ coarctatæ evadunt concavæ)". This is exemplified in Biscutella and Thlaspi. Linnæus borrowed these two terms from Tournefort: he observes, that they are to be understood with some allowance as to the manner in which they are employed. This is candidly observed. "I "should have conceived (says Dr. Martyn) a parallel "partition in a siliqua or pod to have been in the direc- "tion of the valves—a contrary or transverse one, at "right angles with the valves". By some English writers on Botany, the name of transverse dissepiment is given to the dissepiment called by Linnæus contrary.

The *Columella*† is the central pillar in a capsule. It is the part which connects the several internal partitions with the seed: "Pars connectens parietes internos "cum seminibus‡" It takes its rise from the receptacle, and has the seed fixed to it, all round.

* *Dissepimentum contrarium.*

† *Columella*, in Latin, signifies a little pillar, a tomb-stone, or pillar of inscription.

‡ Philosophia Botanica, &c. p. 53. §. 86.

Representations of different kinds of capsules are given in this work*.

2. The Siliqua, Silique, or Pod, is a two-valved pericarp, having the seed fixed along both sutures. The proper silique is bilocular, or two-celled, being furnished with a partition which runs the whole length of this kind of pericarp. It is to be observed, however, that some pericarps which have the same form, take the name of siliqua, although they have no partition, and, of course, are unilocular, or one-celled; as in Fumitory (Fumaria), and Celandine, or Cheledonium.

Linnæus, after Ray, has distinguished the silique into the siliqua, properly so called, and the *silicula*, or silicle. These two pericarps do not essentially differ from each other: they differ only in form and size. The first-mentioned species is much longer than it is broad: we have examples of this kind of pericarp in the following vegetables, viz. Mustard, Radish, Wall-flower (Cheiranthus), Water-cresses, Bignonia longissima, and many others. The silicle is almost round, or at least makes a much nearer approach to the orbicular form; as in the Lunaria (called Honesty and Satin-flower), in Alyssum (Mad-wort), Thlaspi (Shepherd's Purse), Iberis (Candy-tuft), and others. This difference in the form and shape of the silique and silicle, is assumed by Linnæus as the foundation of the two orders into which he has distributed the plants of the xvth class of his system.

* See Plates iv, viii, x, xi, xii, xiv, xv, &c. &c.

a. In regard to its figure, the species of pericarp of which I have been speaking (whether silique or silicle) is, 1. *compressa*, compressed. 2. *torosa*, torose; swelling out into knobs, like the veins and muscles. 3. *torulosa*, swelling as above, but in a smaller degree. 4. *articulata*, jointed; intercepted with tight joints *.

3. The Legumen, or Legume, is a pericarp of two valves, in which the seeds are fixed along one of the sutures only. By this circumstance, it differs from the last mentioned species of pericarp, in which we have seen the seeds are fixed to both sutures. The old English word for the legume was cod †, and the pericarp of the Pea, which is a true legume, is still called a Peas-cod. "Pod (as Dr. Martyn observes) is used both for "the legume and the silique indifferently: but they are "so distinct, that they ought not to have the same ap-"pellation. It seems better, therefore (the same ingenious writer remarks), "to anglicize the Latin terms: "and with respect to this, it is become sufficiently fami-"liar to the English ear‡". In the United-States, it may, however, be observed, that the word cod is much less generally applied to the legume, or any other species of pericarp.

a. In regard to its figure, its substance, &c. the legume is, 1. *subrotundum*, roundish. 2. *ovatum*, ovate. 3. *oblongum*, oblong. 4 *lineare*, linear. 5. *rhombeum*, rhombed, or rhomb-shaped. 6. *rhomboidale*, rhomboi-

* See Plate xxvi.

† Thus May, in the following lines:

"Thy corn thou there may'st safely sow,
"Where in full *cods* last year rich pease did grow".

‡ The Language of Botany, &c.

dal; of a rhomboid form. 7. *lunulatum*, crescent-shaped. 8. *muticum*, awnless; without a point. 9. *obtusum*, obtuse. 10. *acuminatum*, acuminate. 11. *spina mucronatum*, mucronate with a thorn. 12. *venoso-reticulatum*, venose-reticulated; the veins disposed so as to form a net-work. 13. *venoso-varicosum*, venoso-varicose; the veins dilated so as to form varices. 14. *striatum*, striated. 15. *villosum*, villose. 16. *tuberculatum*, tubercled; covered with cartilaginous points. 17. *scabrum*, rough. 18. *planum*, flat. 19. *membranaceum*, membranous. 20. *foliaceum*, foliaceous. 21. *diaphanum*, diaphanous. 22. *coriaceum*, coriaceous. 23. *gibbum*, gibbous. 24. *teres*, columnar. 25. *teretiusculum*, somewhat columnar. 26. *cylindraceum*, cylindrical. 27. *alatum*, winged. 28. *angulis membranaceis*, with membranous angles. 29. *compressum*, compressed; as in Gleditsia triacanthos, called Honey-Locust. 30. *nodosum*, knotty; elevated in knots. 31. *inflatum*, inflated. 32. *turgidum*, turgid; swollen, as in Ononis, and Crotallaria sagittalis (called in the United-States, Rattle, and Rattle-Box). N. B. The turgid and the inflated legume are thought, by some writers, to be no ways different: "but in the latter (as Dr. Martyn observes) "I apprehend the pericarp to be "in substance, as well as in form, somewhat like a "blown bladder; whereas in the former it is merely "more swelled out, and has a wider cavity than usual". We have a good example of the *legumen inflatum* in Colutea, or Bladder-Senna. 33. *torosum*, torose, or necklace-form; gibbous, with protuberances disposed linearly. 34. *farctum*, stuffed; full of a pulpy or fleshy substance. 35. *pulposum*, pulpy; filled with pulp. 36. *carnosum*, fleshy; filled with a fleshy substance. 37.

lignosum, woody. 38. *subulatum*, subulate. 39. *falcatum*, falcate, or sickle-shaped; compressed, subulate, and curved. 40. *sessile*, sessile. 41. *pedicellatum*, pedicelled; elevated on a pedicel. 42. *rectum*, straight; without a bend. 43. *strictum*, stiff and straight. 44. *rigidum*, rigid. 45. *ascendens*, ascending, with an ascending point. 46. *incurvatum*, incurved. 47. *arcuatum*, bowed; bent like a bow. 48. *inflexum*, inflected. 49. *reflexum*, reflected. 50. *revolutum*, revolute.

b. In regard to its measure, the legume is, 1. *longissimum*, very long, with respect to the corolla. 2. *longum*, long. 3. *maximum*, very large, as in Gleditsia. 4. *minimum*, very small; as in the different kinds of Clover (Trifolium). 4. *latissimum*, very broad.

c. In regard to its structure, the legume is, 1. *articulatum*, jointed. 2. *uniloculare*, unilocular. 3. *biloculare*, bilocular. 4. *isthmis interceptum*, divided transversely, within, into different cells.

Plants that are furnished with the legume, as a pericarp, are known by the name of *Leguminosæ*, or Leguminous Plants. The greater number of these vegetables are arranged by Linnæus under his xviith class, or Diadelphia. Of these plants particular mention will be made in treating of the artificial and natural arrangements of vegetables *. It may here be observed, that Dr. Arbuthnot and some other English writers have confounded the siliquose and leguminous plants with each other. Dr. Johnson does not seem to have had correct ideas on the subject†. This, however, is the more

* See Part III.

† See his Dictionary.

excuseable, since the ancients themselves, as Linnæus observes, confounded under one name, the pericarps of the Tetradynamous and Diadelphous plants: that is, the silique and legume. Thus, Columella denominates the pods of Beans, " siliquæ. Virgil uses *siliqua* in the same sense, in the following lines :

" Semina vidi equidem multos medicare serentes ;
" Et nitro prius et nigra perfundere amurca,
" Grandior ut fetus *siliquis* fallacibus esset".

GEORGIC. LIB. I. l. 193-195.

" Though steep'd in nitrous juice and oily lees,
" And seeth'd o'er gentle fires by slow degrees,
" Oft have I seen the temper'd seeds deceive,
" And o'er the treach'rous *pod* the peasant grieve".

SOTHEBY.

WE are certain, from a passage in Pliny, that Virgil is speaking of Beans, and of course, that the word siliquis is properly translated by pod. But the word *legumen* very frequently occurs in the writings of the Roman authors. In these it seems to imply every species of pulse, such as Beans, Pease, &c. Thus Virgil :

" Alternis idem tonsas cessare novales,
" Et segnem patiere situ durescere campum.'
" Aut ibi flava seres, mutato sidere, farra,
" Unde prius lætum siliqua quassante *legumen*.
" Aut tenues fetus viciæ, tristisque lupini
" Sustulerís fragiles calamos silvamque sonantem".

GEORGIC. Lib. I. l. 71-76.

" Alternate fallows rest th' exhausted earth,
" And gradual fit the soil for future birth ;
" Or sow with golden corn the furrow'd clod,
" Where the bean harvest burst the shatter'd pod,

" Or the light vetch and bitter lupine grew,
" Bow'd to the gale, and rattled as it blew".

SOTHEBY.

EVEN Linnæus himself has sometimes confounded the terms siliqua and legumen. Thus in his *Prælectiones in Ordines Naturales Plantarum*, he calls the pericarp of the *Lomentaceæ** a " siliqua" : but at a subsequent period, he denominated it a *legumen*.

FOR representations of the Legume, see Plate XXI.

4. THE Folliculus†, or Follicle, is a one-valved pericarp, which opens longitudinally only on one side, and having its seed loose within it, that is not bound to the suture. In the writings of Linnæus, the terms folliculus and conceptaculum (conceptacle) are entirely synonymous. The latter term occurs in the *Philosophia Botanica*, the former in the *Delineatio Plantæ*, and in the early and late editions of the *Genera Plantarum*.

WE have examples of this species of pericarp in the genera Nerium, Stapelia, Cynanchum, Periploca, Apocynum, Asclepias, Embothrium, and others.

5. THE Drupa, or Drupe, is a species of pericarp which is destitute of valves, and contains a nut or stone within which there is a kernel. The drupe is mostly a moist and succulent fruit, as in the Plum, the Cherry, the Apricot, the Peach, and the Olive : but sometimes, it is dry, as in the Almond. To these two species of

* See Part III. Class x. DECANDRIA.

† *Folliculus*, in Latin, signifies a little leather bag, a husk of Wheat, or other grain.---See page 87.

drupa have been given the names of 1. *succulenta*, succulent, or juicy; containing a fluid, and, 2. *sicca*, dry, or juiceless; opposed to the preceding term.

The term drupa is sanctioned by classical authority. It is employed by Pliny, who uses the word for the fruit of the Olive*. The term is synonymous to Tournefort's "fructus mollis ossiculo", or, soft fruit with a stone. It is, also, equivalent to the term Prunus, as employed by other botanists. The nut, or stone, which in the drupe is surrounded by the soft, pulpy flesh, is a kind of woody cup, which commonly contains a single kernel, called *Nucleus*. The hard shell thus enveloping the kernel, is denominated *Putamen*.

As Linnæus is not always consistent, so the reader will not be surprized to find, that the definition which has just been given of the drupe, does not apply to every pericarp designated by this name in the *Genera Plantarum*. For not, again, to mention the Almond, Linnæus calls the pericarp of the Elm (Ulmus) a drupe, although its substance is like parchment, and its seed are not contained within a stone.

Beside the vegetables which I have mentioned, the following indigenous plants furnish good examples of the drupe, viz. the Sour-Gum and Sour-Olive of the United-States (Nyssa integrifolia and N. denticulata); different species of Laurus, such as Sassafras (Laurus Sassafras), Spice-wood (Laurus Benzoin), and others.

The term drupe gave name to an order, *Drupaceæ*, in the former editions of Linnæus's *Fragments of a na-*

* Lib. xv. cap. vii.

tural method. This order (the thirty-eight) comprehended the Almond, the Peach, the Plumb, the Apricot, the Cherry, and the Bird-seed: but they were afterwards referred to the order *Pomaceæ*, some account of which is given in the last part of this work*.

6. The Pomum, or Pome†, or Apple‡, is a pulpy pericarp, without valves, but containing a membranous capsule§, with a number of cells or cavities, for the lodgment of the seeds. This species of pericarp has no external opening or valve. At the end opposite to the peduncle, or footstalk supporting the pome, there is frequently a small cavity, to which the gardeners have given the name of the eye of the fruit.

The Apple, the Pear, the Quince, the Gourd, the Cucumber, the Melon, and many others, furnish us with instances of this species of pericarp. Several of these plants belong to Linnæus's order Pomaceæ, just mentioned.

a. In regard to its figure, the pomum is, 1. *oblongum*, oblong. 2. *ovatum*, ovate. 3. *globosum*, globular. 4. *subrotundum*, roundish; not to mention many other forms; for the form of fruits is immensely varied by climate, and by soil.

b. With respect to its cells, this species of pericarp is *triloculare*, three-celled, &c.

* See Class xii. Icosandria.

† Dr. Martyn. ‡ Dr. I. E. Smith.

§ "Pericarpium farctum evalve, *Capsulam* continens".

7. The Bacca, or Berry, is a succulent or pulpy pericarp, without valves, and containing naked seeds, or seeds which have no other covering. The seeds, in this species of pericarp, are sometimes dispersed promiscuously through the pulpy substance, as in the Water-Lily: but they are more generally placed upon receptacles, or foot-stalks, within the pulp; as in the Currant, the Gooseberry, the Raspberry, the Hydrastis, called in the United-States, Yellow-root, and many others. To the former kind of seed, Linnæus has given the name of *semina nidulantia*, or nestling seed.

a. The berry assumes a considerable variety of forms. It is, however, very frequently round, or oval, and is often furnished with an *umbilicus*, or small cavity, at the end opposite to the foot-stalk, as is the case in the Apple, and other species of the pomum. This species of berry is called, by Linnæus, *bacca umbilicata*.

b. According to the number of seeds which it contains, the bacca is, 1. *monosperma*, one-seeded; containing a single seed; as in Plinia, &c. 2. *disperma*, two-seeded; containing two seeds; as in Chiococca. 3. *polysperma*, many-seeded; containing several seeds; as in the Persimmon (Diospyros virginiana), Witheringia, May-apple (Podophyllum peltatum), and others.

In the use of the term bacca, or berry, Linnæus is sometimes as inconsistent as in the use of the term drupe. Thus, he calls the pericarp of Lesser-Burdock (Xanthium) a berry: but it is dry, and contains within it a nut, which is furnished with two cells! Again, he calls the pericarp of Capsicum, a berry. But this has

no pulp, and is hollow within. The following pericarps, though, certainly, very different from each other, are all denominated by Linnæus, berries, viz. Sumach (Rhus), Nightshade (Solanum), Sow-bread (Cyclamen), Medlar (Mespilus), Orange and Lemon (Citrus Aurantium and C. medica), Yew (Taxus), and Pine-apple, or Bromelia.

c. The berry is said to be proper, or improper. The former is formed of the pericarp, or seed-vessel. The latter is formed of any of the other parts of the fructification. Thus, in the Mulberry, the Rose, the Blite (Blitum), and Myrtle-leaved Sumach (Rhus Coriaria), the large, fleshy, and succulent calyx becomes a berry. In the Strawberry and Cashew-nut (Anacardium), it is formed from the receptacle: in the Raspberry and Adonis, of a seed: in the Marvel of Peru (Mirabilis) of the nectary: in the Garden Burnet (Poterium Sanguisorba) of the tube of the corolla, which hardens and shuts, for the purpose.

Certain fruits, such as Mulberry, Raspberry, Blackberry, not to mention many others, which are generally regarded as berries, have, with more propriety, been denominated Compound and Spurious Berries: for in these, each of the component parts, which are called *acini*, or granules, may, very properly, be considered as a distinct berry, containing a single seed, immersed in the pulpy matter.

The berry does not spontaneously gap or burst, as do the four first species of pericarp which I have mentioned, viz. the capsule, the silique and silicle, the legume, and the follicle, or conceptacle. Birds and other

species of animals, as we shall afterwards see, are very instrumental in the dissemination or dispersion of various kinds of berries. "Finis Baccæ, says Linnæus, "ut semina ab animalibus serantur: e. gr. *Viscum**".

For representations of different kinds of berry, see, in this work, Plates I, IX, XIV, XVIII.

8. The Strobilus†, or Strobile, is the last species of pericarp enumerated by Linnæus. He defines it, a pericarp formed from an ament by the induration of the scales. This is the definition as given in the *Termini Botanici*. In the *Delineatio Plantæ*, it is thus expressed, "Strobilus imbricatus amenti coaretati". That is, the strobile is made up of scales that are imbricate, or lie over each other, from an ament contracted or squeezed together, in this state of maturity. "This "term includes (as Dr. Martyn observes) not only "the cone of former writers, but also some other "fruits, which recede considerably in structure from "that sort of pericarp; as that of Magnolia", Tulip-tree (Liriodendron), and others. It must be evident, therefore, that it is improper to translate strobilus by cone, as has been done by some writers.

The strobile assumes a variety of forms in different vegetables.

* Philosophia Botanica, &c. p. 75. §. 113.

† Strobilus has very different significations in the Latin language; it signifies a wild Pine-tree, a Pine-apple, an Artichoke, and, also, a whirl-wind.

Although Linnæus, in the later editions of his works, has discarded the term cone, and adopted that of strobile, he has, nevertheless, retained an order of vegetables, which he calls *Coniferæ*, or Cone-bearing, of which notice will be taken in a subsequent part of the work*. To this order belong the Fir, the Pine, the Cypress, the Thuja, and others.

Beside the eight species of pericarp above mentioned, four other species are enumerated by Professor Scopoli, of Pavia. These are the *Theca*, the *Granatum*, the *Cysta*, and the *Scrinum*. Of each of these, it is proper that I should take some notice.

9. The Theca† is defined to be a double involucre of the seed, the exterior covering bursting open; the interior one, which is either pulpy, membranaceous, hairy, or woolly or brittle, envolving the seed. "Fructus "cum involucro duplici; exterius, dehiscens, interius, "pulposum, membranaceum, pilosum, lanatum aut "fragile, semina obvolvens‡". We have examples of this species of pericarp in the Euonymus, or Spindle-tree, and in the Celastrus, or Staff-tree, and several others. Linnæus was not unacquainted with this species of pericarp. He did not, however, consider it as a pericarp, but as the proper and exterior coat or covering of the seed‖, which falls off spontaneously, or encloses the seed partially. I think, however, that the theca may very properly be considered as a species of pericarp. In this opinion, I follow not only the learned Scopoli

* See Part iii. Class xxi. Monoecia.

† Theca, in Latin, signifies a sheath or case, also a box or bag, and the husk of corn.

‡ Necker. See his *Corollarium*, &c. p. 28. ‖ Arillus.

himself, but also Giseke, and some other writers. By some English botanists, the theca has been denominated the Case.

10. The Granatum*, or Granate, is also a double involucre; one of the covers being of a corky or coriaceous texture, the other succulent. In this species of pericarp, however, of which we have the most familiar instance in the Punica Granatum, or Pomegranate, neither of the involucres, or covers, splits or opens.

11. The Cysta†, or Cyst, consists of three covers, one of which is membranaceous, another succulent or fleshy, and the third and most interior also membranaceous or brittle. Neither of these covers splits or opens. "Cysta, fructus minime dehiscens e germine oriens, "triplici involucro. Exterius, membranaceum, fragi- "leve semina involvens". The Berberis, or Barberry, supplies an example of this species of pericarp.

12. The Scrinum‡, or Scrine, is also composed of three covers, viz. an exterior one, which is of a woody texture, and does not split at all; a middle one, which is pulpy, and an interior one, which is membranaceous, envelopes the seed, and spontaneously splits, or opens: "Fructus ex involucro triplici compositum. Exterius, "lignosum minime dehiscens, medium pulposum, in- "terius sponte dehiscens, membranaceum, semina fo- "vens§".

* Granatum is used by Pliny (Lib. xx. cap. xiv.) as the name of the Punica Granatum, or Pomegranate-tree.

† Cysta, or rather Cista, signifies, in Latin, a basket, or chest for books, money, &c.

‡ Scrinum, or scrinium, signifies a casket or coffer, an escritore, a book-case, &c.

§ Necker. Corollarium, &c. p. 17, 18.

I DO not know that names for all of these four species of pericarp have been as yet introduced into the English botanical nomenclature. I think we may use the following, viz. Theca (without any alteration), the Granate (sufficiently distinct from the compound stone called granite), the Cyst, and the Scrine.

§. VII.

THE Semen, or Seed, is the sixth part, and the "end and aim", of the fructification. It is defined by Linnæus, the deciduous part of a vegetable, containing the rudiments of a new or other vegetable of the same species, and fertilized by the aspersion or sprinkling of the pollen, or fecundating powder: "pars vegetabilis "decidua, novi rudimentum, Pollinis irrigatione vivificatum*".

THE parts of a seed, properly so called, are enumerated by the Swedish naturalist, as follows; viz. 1. the *Corculum*. 2. the *Cotyledon*. 3. the *Hilum*. 4. the *Arillus*. 5. the *Coronula*, and, 6. the *Ala*. Of each of these parts I shall give some account, though not in the precise order in which I have mentioned them. I shall, also, take notice of some other parts of the seed, unnoticed by Linnæus; for since his time the subject has excited much more attention than he has devoted to it.

A. I BEGIN with the Hilum†. This part, which is frequently called the Eye, is an external cicatrix,

* Philosophia Botanica, &c. p 54. §. 86.

† The word hilum, in the Latin language, signifies the little black of a Bean, and, also, a very nothing. In this sense it is used by Cicero and by Lucretius.

mark or scar of the umbilical chord of some seeds, where they adhere to the pericarp. In other words, it is the scar formed by the breaking off or separation of the stalk to which it was affixed, and by which it received its nourishment, whilst in the pericarp, or vegetable womb. In the *Delineatio Plantæ*, Linnæus denominates the hilum, "cicatrix umbilicalis", and in his *Philosophia Botanica* he thus defines it: "Cicatrix ex-"terna seminis ab ejusdem affixione in fructu*". This part of the seed is more or less conspicuous in different seeds. In the following, it is very large and conspicuous, viz. the Garden-Bean† (Vicia Faba), in the Cardiospermum, or Heart-seed; and in the Staphylea trifolia, or Bladder-nut.

B. Besides the hilum, we observe, in various species of seeds, particularly when in their green state, a very minute foramen, or hole, of which I think Linnæus has taken no notice. This aperture is perceptible, even without the assistance of a glass, in the full-grown Garden-Bean. In this species of seed, it is situated at the end of the hilum, and immediately at the point of the radicle, which is presently to be mentioned‡.

It is uncertain whether this foramen be present in all seeds. Some writers‖ have supposed, that it is. Possibly, it is constant in all seeds. We cannot doubt that it exists in many in which neither the armed or unarmed eye has detected it. It is so minute, that it may readily escape our notice, especially in small seeds, when they are perfectly ripe and dry.

* Page 54. §. 86.

† See Plate v. Fig. A. 1. Fig. D. 1.

‡ See Plate v. Fig. A. 4.

‖ Mr. Curtis.

The use of this foramen is unknown to us. Dr. Grew, who was acquainted with it, supposed, that the moisture, which the Bean absorbs, when it is committed to the earth, and by which it becomes distended, finds a passage through this aperture. The late Mr. Curtis made an experiment to ascertain the truth of this opinion. He covered the aperture in six Peas (Pisum sativum), with a strong spirit varnish, and placed them in a pot of moist earth, along with six other Pease, which were of the same weight. The following day, he took them out of the pot, and upon weighing them, he found, that the varnished were nearly as heavy as the unvarnished seed, and that there was but little difference in the size of the Pease thus treated. From this experiment, the ingenious experimenter concludes, "that "the moisture which the Pea absorbs, enters the Co- "tyledons by some other channel than the aperture, "most probably the whole surface of the husk is perme- "able*". I think it probable, that the whole surface of the husk is really permeable: but it must be observed, that Mr. Curtis's experiment is not conclusive. His Pease were not left for a sufficient time in the earth, and it does appear, that the seed in which the foramina were not varnished had absorbed, in the course of about one day, *more* moisture than the others.

C. By the Arillus, Aril†, or Tunic‡, Linnæus, as I have already observed, means a particular covering of the seed, to which other writers have given the name of pericarp. I shall not employ arillus, in the Linnæan sense of the word, but shall speak of the coverings of the seed under other names.

* A Companion to the Botanical Magazine, &c. p. 6.

† Dr. Martyn. ‡ Dr. I. E. Smith.

By some writers*, the exterior covering of the seed is denominated the *Cutis*, or Husk. Gærtner†, who has devoted more attention to the seed than any other writer, divides the Proper integuments of seeds (*Integumenta seminum propria*), into the *Testa*, or Shell, and the *Membrana interna*, or Internal Membrane. These are the coats which invest the nucleus (kernel); they do not separate, except under germination, and even then, not spontaneously: they are burst irregularly by the swelling of the cotyledons.

1. When the seed is furnished with two proper coats, the shell is the outer one: when there is only one coat, this is accounted the shell; and when there are more than two coverings, the second from the nucleus is named the shell.

The shell is deemed an essential part of the seed, because the kernel, which originally was wholly fluid, could not have been formed unless a coat had been placed round it. This integument is never wanting.

a. In regard to its consistence, &c. the testa is, 1. *membranacea*, membranous. 2. *pellucida*, pellucid; as in Rice (Oryza). 3. *opaca*, opaque; dry and almost friable; as in Messerchmidia. 4. *chartacea*, paper-like, and somewhat elastic and very tough; as in the Indian-corn (Zea Mays). 5. *coriacea*, coriaceous; thicker than the preceding. 6. *spongiosa*, *fungosa*, and *suberosa*, spongy, fungous, or cork-like; formed of a porous substance. 7. *carnosa*, fleshy. 8. *crustacea*, crusta-

* Curtis, &c.

† See his great and classical work, De Fructibus & Seminibus Plantarum. Stutgardiæ: 1783, & Tubingæ: 1791.

ceous; thin, and not capable of being softened by water, or cut by a knife, but easily broken by the fingers; as in the Palms. 9. *ossea* and *lapidea*, differing from the preceding, only in thickness and hardness.

b. The testa is, 1. *bilocularis*, or two-celled; as in Sapindus. 2. Most generally, however, it is *unilocularis*, unilocular, or one-celled, containing a single kernel.

2. The internal membrane is generally present, but is, nevertheless, often wanting. This integument always closely invests the kernel, but readily secedes from the shell. It is, 1. *membranacea*, or membranous; or, 2. *subspongiosa*, somewhat spongy. The former is the most common.

The Chalaza is situated in the internal membrane. This is a part of the seed of which the learned Gærtner has taken particular notice. It is a small deep-coloured areola, or a small spongy or callous tubercle on the outer surface of the internal membrane of the seed; it is found in many but not in all seeds, and is either placed near the external umbilicus, or diametrically opposite to it. The latter situation is the most common.

3. The Accidental integuments, as Gærtner calls them, are superadded to the testa, or shell, of the seed, and either wholly or partially cover it in such a manner, that they may be easily removed.

The first of these accidental coverings is called by Gærtner, the *epidermis*, or cuticle. It is a thin pellicle,

which invests the whole seed, and never spontaneously separates from it.

The epidermis is, 1. *membranacea*, membranous. 2. *mucilaginosa*, mucilaginous. This is only observed, when seeds, by being thrown into water, have their surface softened and resolved into a jelly, or mucilage. This is very observable in the seed of the Quince (Pyrus Cydonia), and in those of the Siliquose plants.

Gærtner retains the term *arillus*, or aril, as one of the accidental integuments, which covers the seed, either wholly or partially, adhering only to the navel. Of the aril, I have already spoken under the head of pericarp, and have nothing further to say concerning it, in this place.

D. The *Nucleus*, or Kernel, is the part which fills the internal cavity of the various integuments which have been mentioned. It is of an almond-fleshy substance*, and generally composed of four distinct parts, viz. 1. the *Albumen*. 2. the *Vitellus*. 3. the *Cotyledon*; and, 4. the *Embryo*. Of these I shall treat in the order in which I have mentioned them.

1. The Albumen, or White of the Seed, is that part of the kernel which invests the cotyledons, and is thought to afford the same support to the germinating embryo, that the white of the egg does to the chick. Both in respect to its consistence and colour, the albumen, in many seeds, greatly resembles the white of a boiled egg. It is not deemed an essential part of the

* That is retaining the impression of the nail. Gærtner calls it *amygdalino-carnosum*.

seed. It is wanting in many seeds, but, upon the whole, appears to be present in a majority of the many seeds which were examined, with a truly scientific patience, by Gærtner. It is present in the plants of the following natural orders, viz. the Grasses, the Palms, the Liliaceous plants, the Umbelliferæ, the Coniferæ, and the Multisiliquæ, not to mention some others. The albumen is wanting in the seeds of the Compositæ, the Verticillatæ, the Siliquosæ, the Cucurbitaceæ, and the Asperifoliæ. In the Leguminous plants, a very great number of the genera are destitute of albumen, whilst a few are supplied with it. Among the plants of the class Monadelphia, there is a greater number of genera with albuminous than with exalbuminous seeds.

Although the albumen is thus wanting in many seeds, it must be admitted, when present, to be a substance of considerable importance. It supports and defends the embryo, whilst this essential part is imprisoned in the seed, and serves for the first nutriment of the embryo, when it begins to germinate. It has no connection with the embryo, whether it surround, or is surrounded by, the embryo: it is always so distinct, as to be very readily detached from it.

The part of the kernel of which I am speaking, was not unknown to Dr. Grew, who gave it the name which it now retains. Gleichen calls it the "seminal placenta", whilst Meese and Boehmer designate it by the name of *cotyledon*. Linnæus asserted, that the vegetable egg is destitute of albuminous matter, and that it is of no use in the seed. He would have said, with more truth, as Gærtner observes, that albumen is

not found in all seed. Moreover, some seeds have but a very small quantity of this substance.

2. The Vitellus, or Yolk, is placed between the embryo and the albumen, and is different both from the cotyledons and the albumen. It is so closely connected with the embryo, that it cannot be detached from it, without injuring the substance of the latter. It is never carried without the shell of the seed, whilst this is germinating, nor does it become a seminal leaf, as the cotyledons do, but is entirely exhausted by the seminal plant and converted into its nourishment; in both which respects it resembles the albumen. In albuminous seeds, or seeds furnished with albumen, the vitellus occupies the middle place between it and the embryo, in such a manner, that it can be easily separated from the albumen, without any injury to its form. It is evident, therefore, that it has some affinity with the cotyledons, and also with the albumen. Of all the internal parts of tue seed, the vitellus is the most uncommon.

In the seeds of what are commonly called the more imperfect plants, such as the Fuci, the Mosses, and the Ferns, the vitellus presents itself in its most simple form and fabric. In these plants, the whole kernel is a pure vitellus, which is formed of mere herbaceous or almond-flesh, and exactly adapted to the cavity of its shell. Even here, although the *diagnosis* of it is difficult, it cannot, in the opinion of Gærtner, be referred to the albumen, because it does not contain within itself a distinct embryo, but is perfectly solid. Moreover, near the umbilicus of the seed, the vitellus has growing to it, a "germinating cicatricle", which is not separable

from the remaining substance of the kernel, nor even distinguishable from it, except by its paler colour, and more medullary consistence; as we observe in the seeds of Lycopodium. Nor can the substance in question be considered as a solid cotyledon, because in the germinating seeds of the Mosses, we plainly observe cotyledonous leaflets, arising below it from the seed; and it is seen adhering to these new and true cotyledons, a long time after their appearance, and the seminal plant consuming and destroying it. The vitellus, from all these circumstances, appears to be of an intermediate nature, between the albuminous and cotyledonous matter.

In other vegetables, as in Ruppia and Zamia, the fabric of the vitellus is more evident. In the first of these plants, it is very like to a fleshy albumen, and in Zamia, it is still more like albuminous matter. In Zostera, Ceratophyllum, and others, the vitellus approaches nearer to the form of a true cotyledon, being formed of a white almond-flesh, and divided into two lobes. In Ceratophyllum and Nelumbo, indeed, there is but little perceptible difference between the vitellus and the cotyledons. Upon the whole, however, the vitellus, in the opinion of Gærtner, constitutes a distinct kind of viscus*.

3. As the texture of the albumen is much more simple than that of the vitellus, so the fabric of this last-

* In describing the different parts of the seed, such as the albumen, the vitellus, &c., I frequently employ, with but little alteration, the words of Gærtner, in his extensive history of these parts. Candour requires me to make this acknowledgment; and whilst I make it, I must not omit to refer the reader, who is anxious for more minute information concerning the history of the seed, to the learned and ingenious work of the German botanist.

mentioned part is less perfect than that of the cotyledons, which now claim our attention.

The cotyledons* are organized parts of the kernel, simple or divided, which together with the radicle and plumule form the body of the embryo, which is next to be treated of, and by the germination of the seed, are commonly converted into the first leaflets of the new plant, which, in general, are different from the succeeding leaves. This is the definition of Gærtner. Linnæus defines them to be the lateral body of the seed, bibulous or imbibing moisture, and caducous, or falling off quickly: "corpus laterale seminis, bibulum, caducum†". Professor Giseke defines it "folium primum germinantis seminis"‡: the first leaf of the germinating seed. But this is rather a definition of the seed-leaf. In English, the part of which I am speaking, is commonly called the Seed-Lobe, "when we speak of it as "a portion of the seed, in a quiescent state—and the "seed-leaf, when the seed is in a growing state §".

From different writers, the cotyledons have received different names. Jungius, in the seventeenth century, denominated them *Valvæ seminis*, or Valves of the seed. Gleichen called them *Lobi seminales*, or Seed-lobes: whilst by others, they have been called *Foliola seminalia*, or Seminal-leaflets. Linnæus adopted the name of cotyledon, which is used by Gærtner, and most of the other modern writers on botany; and which, indeed, seems preferable to any of the other appellations. In English, we shall avoid all ambiguity by employing

* From κοτυλη, a cavity.

† Philosophia Botanica, &c. p. 54. §. 86. ‡ Termini Botanici.

§ Professor Martyn.

the Latin word, cotyledon, only using, in the plural, cotyledons.

The cotyledons seem to derive their original from the embryo, of which they always constitute an integral part. In particular, the simple or undivided cotyledons are supposed to be formed by the mere extension of the corcle*, or first medullary point of the seed, and are nothing else than the scape of the embryo more or less distinct from its radicle; as in the Palms, the Grasses, and the Liliaceous plants. On the other hand, however, the double or conjugate cotyledons are formed by the fissures, which divide the part of the corcle, opposite to the radicle, into two lobules, which are generally equal.

a. In regard to its fabric, the cotyledon is generally composed of three distinct parts, viz. epidermis, or cuticle, parenchyma, and tracheæ, or vessels. 1. The cuticle invests the whole surface of the cotyledons, and, in the opinion of Gærtner, serves them partly as a filtre, through which the liquor of the amnion passes, and partly hinders them from coalescing with the neighbouring bodies. 2. The parenchyma proceeds from the internal bark of the embryo, and is formed of cellular texture, in the interstices of which are deposited a thick oil, and other inspissated liquors. This parenchyma alone forms nearly the whole mass of the cotyledons, and is commonly of an herbaceous, almond, or somewhat coriaceous consistence, and principally serves the purpose of depurating and containing the nutritious juices. 3. The tracheæ, or vessels, are dispersed

* See what is afterwards said on the Embryo.

through the whole cellular texture of the cotyledons, and connect them intimately with the contained embryo*. They seem to arise from the fleshy substance of the embryo, immediately below the origin of the plumule, and terminate with their fine extremities in the parenchyma, or the surface of the cotyledons. It is supposed†, that they are of use to the seminal plant by performing the two-fold office of exhaling and absorbing vessels. Whatever may be their precise use, it is probable, that they perform for the seed, an office similar to that which is performed by the apparently-same system of vessels, which are so conspicuous in the leaves and other parts of vegetables‡. The tracheæ are, at all times, conspicuous in the thinner cotyledons; and in the thicker ones, they are rendered obvious to the senses by germination, and different coloured fluids, which they greedily absorb. We cannot doubt, that this absorption depends upon a living principle (irritability), inherent in the vessels of which I am speaking: for the absorption, or propulsion of fluids, is observed to be considerably increased by the application of various stimulating agents, such as camphor, nitre, &c.

b. The number of the cotyledons is different in different seeds; upon the whole, however, the number of these parts is more constant than that of any other part of the fructification. Hence, as we shall afterwards see, some eminent botanists have founded their methods of vegetables principally upon the number of the cotyledons.

* See Plate v. Fig. F. † By Gærtner, and others.
‡ See page 49, &c., and, also, Part II.

A SEED, in the language of the botanists, is, 1. *Acotyledonous*. 2. *Monocotyledonous*. 3. *Dicotyledonous*. or, 4. *Polycotyledonous*.

1. THE seeds which are destitute of cotyledons are named Acotyledonous seeds, and the plants which arise from such seeds, Acotyledonous plants. The acotyledonous seed has no conspicuous or distinct embryo, but contains within itself only a *punctum saliens*, or mere germinating cicatricle; or a certain simple *primordium* of a radicle, implanted in the kernel, and which is several times larger than itself; as in Ruppia, Zostera, Zamia, the Fuci, the Mosses, the Ferns, and the Fungous plants.

A PLANT is named acotyledonous, which, without any preceding vestige of a true leaflet, arises from the earth, a frond of different species, but perfectly similar to the parent plant. Plants of this kind are seldom propagated from seed, but more commonly spring from simple or fruit-like *(carpomorphi*)*, buds, as is the case with respect to the Fungous plants, the Lichens, the Confervae, and some of the Algae†.

LINNÆUS‡, Adanson, Jussieu, Gærtner, and other able botanists, have no hesitation in asserting, that there are seeds, which are acotyledonous, or destitute of cotyledons. On the other hand, however, Dr. Hedwig, of Leipsic, of whom it has been said, that he was "born to abolish Cryptogamy", asserts, that there are no seeds whatever destitute of cotyledons; that the

* Gærtner. † See Part III. Class XXIV. CRYPTOGAMIA.

‡ "Musci et adfines (says Linnæus) solis Cotyledonibus destituuntur". Philosophia Botanica, &c. p. 89. §. 136.

powder of the Mosses (a tribe of plants which the botanists, whom I have mentioned, arrange under the head of *Acotyledones*) is the genuine seed of these plants, which are furnished with their proper cotyledonous matter, as in other plants. "Pulvisculus (these are his words) "igitur Muscorum intra capitula contentus, "verum eorum est semen, quod, veluti aliorum vege- "tabilium semina, sua tunica, *cotyledone* uno et ultra, "et plantulae rudimento instruitur*". Notwithstanding, however, the truly ingenious and meritorious labours of this author, it still, I think, remains to be ascertained, whether the Mosses are really furnished with cotyledons, or not. Meanwhile, I follow the authors above mentioned, in retaining a head or class of acotyledonous seeds.

2. The Monocotyledonous seeds are such as have only one cotyledon, or lobe, in the seed. A seed of this kind contains with it a very entire embryo, without any perceptible chink, and is either entirely free, or at least loose from the rest of the kernel, at the extremity opposite to its radicle.

Monocotyledonous are much more numerous than acotyledonous, plants. To the former head, are referred the great natural families of the Grasses, the Palms, the Scitamineæ†, the Liliaceous, and many other, plants. Gærtner observes, that these seeds are of two kinds, viz. 1. the *true* monocotyledonous, having the embryo formed from its first production, of one in-

* D. Joannis Hedwigii, &c. Fundamentum Historiae Naturalis Muscorum Frondosorum, &c. Part II. p. 55. Lipsiae: 1783.

† See Part III. Class I. Monandria.

dividual body, and so composed of a medullary and cortical substance, that in every transverse section of the embryo, the double substance appears both distinct, and very entire: and, 2. *false* monocotyledonous *(pseudo-monocotyledonea)*, containing, as well as the former, a solid and undivided embryo, but at its first production, parted into distinct lobules, and afterwards, from the lobules being united at maturity, transformed into a solid and individual body; as in Tropœolum, Paullinia, and others.

Gærtner also divides the monocotyledonous plants into *true* and *spurious*. The true monocotyledonous plants observe one and the same mode of germinating and of growing, and, consequently, have the same habit of external form. To this head we refer the Grasses, the Cyperoideæ, the Liliaceous plants, the great family of Orchides, the Scitamineæ, the Palms, and others. The spurious monocotyledonous plants only agree in the mode of germinating with one another, and with the former; whilst, in regard to their other qualities, they differ in almost every point; as in Nelumbium, Trapa, Ceratophyllum, Cuscuta, Orobanche, and others. Hence, a plant is generally named monocotyledonous, which springs from the shell (testa) of the seed, with a single true leaflet, or with a single filiform shoot, or *turio*.

The monocotyledonous plant which arises from the shell with a leaflet, is denominated phyllophorus, or leaf-bearing *(phyllophora)*; and that which arises with a filiform shoot is called turioniferous, or shoot-bearing (*turionifera*). These last are either completely destitute

of leaves (*aphyllæ*); as in Cuscuta and Melocatus; or they are bulbiferous (*bulbiferæ*), when the embryo of the seed is first elongated into a fleshy staff, then the outer extremity of it is enlarged into a bulbous globule; and from this globule arises the first leaflet.

3. The seeds which are furnished with two cotyledons, are denominated Dicotyledonous, and are by far the most frequent. They cherish within them an embryo, separating spontaneously into two lobes, or, at least, divided by a conspicuous chink, in the extremity opposite to the radicle.

The dicotyledonous seeds are, in general, very readily distinguished from the others, besause, in by far the greater part of them, the cotyledons are manifestly distinct from each other, as in the Garden-Bean, and many others*. In some of the seeds of this class, however, the diagnosis, as it is called, is attended with some difficulty. This difficulty occurs, when the cotyledons, now arrived at maturity, have coalesced into one undivided body; or, again, when in the more minute embryos, the chink of the division is so very small, that it cannot be properly distinguished, even when the eye is assisted by a magnifying glass. In the former case, it is advised to cut the seed before its complete maturity, or the mature kernel is to be determined and referred to its proper class, agreeably to the signs, already mentioned, when speaking of the false monocotyledonous seed†. In the latter case, it is useful, in many in-

* See Plate v. Fig. F.

† All the false monocotyledonous seeds, according to Gærtner, properly belong to other classes, and most of them are dicotyledonous.

stances, to throw the doubtful embryo into a coloured liquor, very readily diffusible, such as that of the Phytolacca, or Poke, that this liquor may be received within the chink, and thus render it more conspicuous to the eye. If, notwithstanding these precautions, we cannot satisfy our minds, then the seed is to be referred to the head of monocotyledonous seeds, even though we are certain, that it has originated from a genuine dicotyledonous plant.

The greater number of dicotyledonous plants arise from the earth with two seminal leaflets (*folia seminalia**), but sometimes they leave their cotyledonous lobes hidden beneath the surface of the earth, and rise, to meet the light and air, with their plumule only. This difference has given occasion to distinguish the dicotyledonous seeds into, 1. epigean, and, 2. hypogean.

The epigean *(epigœæ)* cotyledons are always the forerunners of the appearance of the new plant, and either resemble thick herbaceous lobes, as in the Kidney-Bean, and other Leguminous plants; or they resemble true leaves, in general, however different from those which are to follow, as in the Compound-flowers, and others; and they spontaneously fall off, after the plumule has unfolded itself.

The hypogean (*hypogœæ*) cotyledons are only to be met with, in some of the exalbuminous seeds formerly mentioned†, the testa, or shell, of which they very exactly fill, and never throw it off. They, therefore, always consist of thick and fleshy lobes, and these are

* See Plate v. Fig. H. and Fig. O. † See page 204.

either united, as in the Horse-Chesnut (Æsculus Hippocastanum), &c. or they are distinct, as in the Walnuts and Hickeries (Juglans), and others. These, for the most part, even before germination, cherish in their bosom, a manifest plumule, which, of itself, is capable of evolution.

4. The Polycotyledonous seeds are those which have more than two cotyledons; or, in other words, those in which the embryo is divided into more than two lobes. In general, they are easily distinguished from the other seeds, already mentioned. The cotyledons are found to be more than two in various plants. Thus, there are three cotyledons in the Hemlock Spruce-Fir (Pinus canadensis); four in Rhizophora gymnorrhiza, and in Avicennia; five in the Common Pine (Pinus sylvestris); six in the Garden-cress (Lepidium sativum), and ten, twelve, or more, in the different species of Pine. In all these plants, the lobes are observed to be perfectly equal, except in Canarium and Lepidium. They are, likewise, distinct in all, except Hernandia, the cotyledonous kernel of which is solid, and only many-parted, internally, by indistinct streaks. But polycotyledonous plants do not arise exclusively from these seeds; they are actually known to arise from acotyledonous seeds, as from Mnium hygrometricum, from Bryum trichodes and B. argenteum, and from various Fuci. Moreover, true dicotyledonous seeds sometimes counterfeit the polycotyledonous, namely when the nucleus, or kernel, owing to the abundance of nutriment, is divided into various irregular lobes, as in Mangifera domestica; or into minute bractes, which do not cohere with each other, as in the Shaddock (Ci-

trus decumana): but this structure is, unquestionably, monstrous, and cannot deceive the botanist who is well versed in inquiries of this nature.

David Meese was of opinion, that there are no seeds furnished with more than two cotyledons*; and Mr. Adanson asserts, that the polycotyledonous seeds only differ from those which are dicotyledonous, in this, that the lobes of the former are again deeply divided, and that their lobes are, in reality, only two in number. The opinion of the French botanist has been implicitly adopted by many succeeding botanists, among whom I may mention the learned Mr. de Jussieu†. It is certain, however, that there are seeds entitled to the appellation of polycotyledonous seeds. This is evident from the unequal number of the lobes, as a ternary and quinary one, in some species of Pine. The polycotyledonous plants, however, are, on all hands, acknowledged to be but few in number.

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As the number of cotyledons is upon the whole pretty constant, and rarely varies in the same family, so many botanists have founded their methods of plants chiefly upon the number of these parts. Thus, Ray,

* Plantarum Rudimenta, &c. &c. 1763. 4°.

† Genera Plantarum, &c. p. 415. Mr. Curtis (*A Companion*, &c. p. 20.) positively asserts, that the seed of the Pine has only one cotyledon, and that what have been taken for the cotyledons "was, in fact, the plumule expanded into a "considerable number of narrow leaves".

Boerhaave, Heister, Meese, Adanson*, and others, have assumed the number of the cotyledons as the basis of their systems, and have divided the vegetables of which they treat generally into Acotyledonous, Monocotyledonous, Dicotyledonous, and Polycotyledonous. This division is, likewise, the foundation of the celebrated, and, in many respects, natural method of Mr. de Jussieu, to which I shall have frequent occasion to refer, in the last part of this work. This distribution, however, does not afford classes of vegetables sufficiently natural for the purpose of the botanist: and is, moreover, liable to considerable difficulties. We cannot learn, with absolute certainty, the true number of the cotyledons, unless when we have an opportunity of inspecting the seed in a germinating state; nor will the fabric of the embryo, in every case, enable us to form a safe judgment of the number of the future cotyledons; for it is found, as has been already observed, that sometimes, as in the Mosses, a polycotyledonous plant proceeds from an acotyledonous seed; that from a monocotyledonous plant occasionally proceed plants which are closely allied to the dicotyledonous plants, as in Dodder (Cuscuta), and in Melocactus. Lastly, it is certain, that from a seed which is manifestly dicotyledonous, there may spring plants which are attended by only one cotyledonous leaflet; as in the genera Nelumbium and Trapa. Upon the whole, while it will readily be admitted, that although the number, the fabric, and physiology of the cotyledons are points which ought never to be neglected by the genuine botanist, it is highly improbable, that a

* This truly learned botanist has founded two systems on the cotyledons, the one on the number, and the other on the form, of these parts.

methodical distribution of plants from the number or form of these parts of the seed, will ever be generally received.

c. In general, when there are two or more cotyledons in a seed, they are equal, or of the same size, &c.: in some instances, however, we do observe a difference both in regard to the size and thickness of the cotyledons. But germination finally abolishes the difference; and it is observed, that the cotyledons of the same seed, when evolved, are both very generally equal and very similar, to each other.

d. The size of the cotyledons is various in different vegetables. Most of the exalbuminous seeds have very large cotyledons; as in the Compound-flowers, the Verticillate plants, &c. On the contrary, in the Umbelliferæ, the Stellatæ, and some other natural families, the cotyledons are smaller. That is, in the first case, they either fill the whole of the shell of the seed; so that, when it is opened, we observe nothing but the cotyledons and the radicle; or, in the second case, they are nearly of the length and breadth of the seed-shell, but owing to their albuminous matter, do not completely fill it; or, lastly, they are sometimes hardly discernible, even by means of a glass: as in Heath (Erica), Columbine (Aquilegia), Ranunculus, and others. Gærtner enumerates four heads of sizes of the cotyledons, viz. very large *(maximæ)*, middle sized *(mediocres)*, small *(parvæ)*, and minute *(minutæ)*.

e. The absolute situation of the cotyledons is supposed to be always in the highest part of the radicle, although this be inverted, or those be turned to the side

of the radicle, or rolled about it. But the relative situation respects the situation which the cotyledons hold among themselves, or in respect to the external regions of the seed.

Cotyledons, with respect to each other, are, 1. *contiguæ*, contiguous; their internal surfaces touching mutually in every point; as in by far the greater number of known vegetables. 2. *oppositæ*, opposite; their internal surfaces mutually respecting each other; but, by reason of the inflected margins, either not able to touch each other at all, or not in all points; as in Meadow Crane's-bill (Geranium pratense), Coldenia, and others. 3. *collaterales*, collateral; when one cotyledon is placed at the side of the other, in the same vertical plane, so that it is only at their internal margins that they can mutually respect or touch each other; as in the Misceltoe (Viscum album), Menispermum Coculus, and, in some measure, in Cachrys. 4. *divergentes*, diverging; joined at the base, but taking a contrary direction at the apex; as in Nutmeg (Myristica), and Menispermum fenestratum. 5. *verticillatæ*, verticillate; placed in a circle, about a common point, so that they mutually touch each other; as in Pine, and Rhizophora.

Cotyledons, with respect to the external regions of the seed, are, 1. *incumbentes*, incumbent; when one of the cotyledons respects the back, and the other the belly of the seed, so that the plane of mutual contact is parallel with the axis of the fruit; as in Henbane (Hyoscyamus), Campion (Cucubalus), &c. 2. *accumbentes*, accumbent; when one respects the right and the other the left side of the seed, and the margins are turned to

the back and belly of it, so that the plane of contact is contrary to the axis; as in the Leguminous plants, and others. 3. *transversales*, transverse; which have an oblique, or irregular situation in the seed, as in Myrsine, and Lathræa, &c.

f. Almost all the known cotyledons have a continuity of substance, and a perfect equality of surface: yet some variations from these rules do occur. Thus, some cotyledons are, 1. *dentatæ*, toothed, or serrated in the margin; as in the Lime-tree (Tilia). 2. *partitæ*, parted; their foliaceous plates more or less deeply divided into equal parts. 3. *rimosæ*, or *anfractuosæ*, chinky; having their thick lobes divided by chinks, and deep furrows into various irregular lobes, cohering with each other, and not separated by an intervening membrane; as in Beech (Fagus), &c. 4. *ruminatæ*, ruminate; like the preceding, except that the chinks are principally placed in the external surface; and separated by intervening membranous plates; as in the Chesnut (Fagus Castanea). 5. *lobatæ*, lobed; when each primary lobe is again divided into other smaller lobes, on the exterior surface only; as in the Walnut. 6. *fenestratæ*, windowed; pierced with many round holes; as in a species of Menispermum, called, on account of this very singular structure, M. fenestratum.

g. Very often the figure of the cotyledons is not different from that of the whole embryo, especially in the monocotyledonous and various other seeds: but, in most seeds, it is worthy of a separate consideration, and either according to the straightness or curvature of the plane of contact, or according to the circumcesure

of the cotyledons. Thus, the cotyledons are, 1. *rectæ*, straight; when the internal surfaces, or plane of mutual contact, as well with respect to their length or breadth, hardly deviate from the right line. 2. *arcuatæ*, bowed; generally narrow, and always longer than they are broad: the axis, also, is curved in all, but the breadth of the surfaces is always straight and flat. 3. *reniformes*, reniform; the nearest to straight, as in the Leguminous plants. 4. *falcatæ*, sickle-shaped. 5. *uncinatæ & semicirculares*, hooked and semicircular. 6. *cochleatæ*, cochleate; which make one or two spiral turns; as in Cistus. 7. *vermiculares*, vermicular; bowed in an irregular manner, as in Scorpiurus vermiculata. 8. *flexuosæ*, flexuose. 9. *carinatæ*, keeled; the axis projecting into an angle, but the flattish sides bent either forwards or backwards; as in Privet (Ligustrum). 10. *conniventes* or *subconduplicatæ*, converging, or somewhat conduplicate: these, from their situation, are opposite, and their sides are inflected in such a manner that the half of one plate is received within the duplicature of the other; as in Meadow Cranesbill and Coldenia. 11. *repandæ*, repand; the plates being curved in contrary directions, only near the margin, but, in the middle, are sufficiently flat, and are marked with a round angle; as in Tilia, Buckwheat (Polygonum Fagopyrum), &c. 12. *plicatæ*, plaited; plaited like a ruffle into contiguous vertical or transverse wrinkles, as in Sebestena, &c. 13. *lacunosæ*, pitted; having their internal surfaces marked with rude and thick folds; as in Beech, &c. 14. *volutæ*, volute; differing from all the preceding, because their foliaceous and very broad plates are rolled in various ways about a globe, or cylinder,

or each other, and curved in all directions *. 15. *convolutæ*, convolute; strictly so called. 16. *cylindricæ*, cylindrical; simply rolled into a hollow cylinder; as in Pisonia. 17. *spirales*, spiral; the foliaceous plates rolled, in a spiral direction, about the radicle or plumule; as in the Pomegranate (Punica), Myrobalanus, &c. 18. *duplicato-convolutæ*, doubly-convolute; having both margins reflected spirally into the middle of the internal surface; as in the Nelumbo. 19. *vaginantes*, sheathing; the outer plate cylindrically convolute, and embracing the internal, doubly convolute; as in Aubletia, Rivinia, &c. 20. *contortuplicatæ*, writhed, or contortuplicate; plaited and convolute in an almost inextricable manner; as in Mallow (Malva), Cotton (Gossypium), Convolvulus, and others †.

"THE proper figure of the cotyledons, which is "defined by the limits of the circumference of the mar- "gins alone, and is equally common to the straight and "curved cotyledons, has exactly the same modifica- "tions" that the true leaves (formerly considered‡) have, being, like them, linear, lanceolate, oblong, ovate, cordate, &c., except, that the margins of the co-

* To this head are referred cotyledons that are, 1. *concavæ*, concave, or spoon-shaped *(cochleariformes)*; as in Myristica officinalis. 2. *conglobatæ*, conglobate; formed into a sphere, which is smooth on the outside, but plaited within in various ways; as in Cabbage (Brassica), &c.

† It is not expected, that students in botany, much less those who merely pursue plants as an object of pleasure, are to become thoroughly acquainted with this extensive and very difficult nomenclature of the cotyledons. In a work, however, such as the present, it would have been improper to have omitted this terminology, which we owe to the persevering industry and nice discrimination of the learned Gærtner.

‡ See pages 31, &c. &c.

tyledons are very rarely toothed or incised, and hardly ever irregular. As true leaves, so likewise the cotyledons have a different form in the different species of one natural genus, or family. Thus, in the Tartarian Maple (Acer tataricum), the cotyledons are gibbously flexuose, whilst in the Red-Maple (Acer rubrum), they are spiral, &c. Thus, again, in the Mountain-Dock, or Sorrel (Rumex digynus) they are quite straight, but in Bloody-Dock (Rumex sanguineus) and in Blunt-leaved Dock (Rumex obtusifolius), they are slightly curved, &c. &c. It is to be observed, however, that these differences, which are so very frequent in the true leaves, very rarely occur in the cotyledons. Indeed, it is very common for all the cotyledons of one genus or family, and even of two natural classes, to be very similar, and absolutely of the same form; as in the Umbelliferous plants, and others. This circumstance must show the necessity, or at least the propriety, of carefully studying the history of the cotyledons, in every attempt towards a natural arrangement of vegetables. Indeed, without a minute attention to the cotyledons, we shall never possess, what it is a matter of so much consequence to possess, A PHILOSOPHICAL HISTORY OF THE VEGETABLE KINGDOM.

b. THE most common colour of the cotyledons is a pure milky white. Yellow-coloured cotyledons are not uncommon, especially in the ripe seeds of siliques and legumes. Some cotyledons are of a dark or grass-green colour*. In the seeds of the two genera Sonchus and

* When, besides this colour, cotyledons have, likewise, a foliaceous figure, the seeds are said to be germinating *(germinantia)*, as in Nelumbo.

Scorzonera, the cotyledonous matter is of a livid or leaden colour; and in the seeds of Bidens and Zinnia, it is of a purplish colour. But these colours are unusual, and they are all, by the great process of germination, converted into green; though sometimes into a fine-blood colour, as in some species of Amaranthus, &c.

i. In regard to their odour and tastes, it is certain that, in general, the cotyledons have but little or no odour; or, at least, not a sweet or aromatic odour. For although the fruits of Cinnamon (Laurus Cinnamomum), and Clove (Eugenia caryophyllata) possess a very fragrant smell, yet this is entirely lost in the completely-matured cotyledons. In some seeds, the taste of the cotyledonous matter is bitter, as in Quassia excelsa; in others, it is acrid: but very generally it is insipid and mealy, or sweetish, as in the recent kernels of the Almond (Amygdalus communis), the Filbert (Corylus Avellana), and different species of Walnut and Hickery, such as Juglans regia, J. nigra, Shell-bark Hickery (Juglans alba ovata*), and others.

IV. The *Embryo* is the most noble and essential part of a fertile seed. It is the part which exclusively forms the *nova progenies*, or new plant, and to which all the other parts are added, for its temporary use only. To this part Linnæus, after Andreas Cæsalpinus, gave the name of *Corculum*, or the little heart. Dr. Martyn calls it Corcle. Some writers have named it *plumula semi-*

* Of Marshall.

nalis *, or the seminal plumule. Adanson and Gærtner designate it by the name of embryo, a term which I do not hesitate to adopt in preference to either of the others, which I have mentioned†.

According to Gærtner, the embryo derives its origin from the medullary point *(punctum medullare‡)*, produced by fecundation; and, this point, he thinks, might more properly be named the corcle of the seed, "because in it alone resides the fountain of all vegeta-"ble life, and from it alone proceeds the whole vascular "system of the embryo". In some cases, the corcle is so little augmented, that, even in the matured seed, it is either altogether imperceptible, or it appears only like a paler point or dot, which Gærtner names the cicatricle (*cicatricula*), and which has nothing of the embryo but the principle of life (or the capacity of being roused to the possession of life), and the faculty of germinating. In other cases, the medullary point gradually passes into a columnar radicle, which projects above the kernel at its free apex, and at its base grows firmly to the same. Lastly, in other cases, the corcle, on all sides loose, grows at both of its extremities, from one of which it puts forth the radicle, and from the other the newly-organized parts, which are named cotyledon and plumule. Hence, there arises a four-fold difference of the embryo, from the increase of the corcle within the seed, viz. 1. *imperfectus*, imperfect; an embryo, which, to use the words of Gærtner, is "merely potential",

* Professor Ludwig calls it Plantula seminalis.

† See Plate v. Fig. C. 3. 4. Fig. F. 1. 1. 2. 3. Fig. G 1. Fig. H. 1. 2. Fig. L. 1. Fig. N. Fig. O.

‡ See page 208.

as being formed from the germinating cicatricle alone. 2. *incompletus*, incomplete; formed of a simple, fixed radicle alone. 3. *perfectus*, perfect; constructed of a free radicle and plumule. 4. *completus*, complete; composed of a radicle, cotyledon, and plumule.

THE *consistence* of the embryo in all is soft and herbaceous, fleshy, except in Rhizophora, the radicle of which is converted, at maturity, into an almost woody hardness. The *internal fabric* of the embryo is very simple, being formed from the medulla alone, and surrounded by its proper bark, in the more simple embryos. But in other embryos, vessels are observable. These vessels arise from the lobules of the plumule or cotyledons by an insensible beginning, and gradually anastamosing or uniting with each other, they run through the whole substance of the embryo, and finish in its outermost radicle. This vascular structure is beautifully conspicuous in the embryo of the Persimmon (Diospyrosvirginiana), when it is viewed through a magnifying glass*. The *external fabric* is generally owing to three distinct parts, which are peculiar to the embryo, and denominated the Plumule, the Scape, and the Radicle. Of these parts I shall speak, separately, afterwards.

a. IN regard to the figure of the embryo, it is to be observed, that this arises principally from the cotyledons, joined to the radicle, especially in the solid or true monocotyledonous embryos, which are almost entirely made up of the cotyledon alone, and frequently

* See Plate v. Fig. O.

have a peculiar form, which is not to be met with in others.

α. The solid or true monocotyledonous embryo is, 1. *trochlearis*, pulley-like; consisting of a short cylinder narrowed in the middle, or as if composed of two globules; as in Commelina, &c. 2. *pyramidalis*, pyramidal; rising from a broad radical base into an acute point, which is either longer, or shorter, or cylindraceo-acuminate. 3. *fungiformis*, fungiform; from a narrow radical base, enlarged into a thick head or pileus; as in Carex, &c. 4. *patelliformis*, patelliform; from a very minute radical tubercle, extenuated into a round saucer; as in Flagellaria.

β. The dicotyledonous and the remaining monocotyledonous embryos are, 1. *recti*, straight. 2. *crassi*, thick. 3. *foliacei*, foliaceous. 4. *curvi*, curved. 5. *arcuati*, bowed. 6. *falcati*, sickle-shaped. 7. *uncinati*, uncinate. 8. *cyclici*, cyclical. 9. *conduplicati*, conduplicate; having the radicle accumbent on the sides or chink of the cotyledons, or having generally the extremities either not at all separated, or at least only separated by a narrow space; as in Hemp (Cannabis), and various Leguminous and Siliquose plants. 10. *spirales*, spiral. 11. *gnomonici*, gnomonic, or like a dial; having the scape inflected at a right angle; or having the radicle joined at an obtuse angle with the cotyledons. 12. *serpentini & sigmoidei*, serpentine and sigmoid; having the axis bent in a contrary direction near the two extremities, or irregularly curved throughout its whole length; as in Lily (Lilium), and Tulbagia, &c.

b. In regard to their situation, embryos are, 1. *centrales*, central; either filling the whole cavity of the shell, or placed only in its axis, and within the albumen; as in the greater number of seeds, particularly in the Umbelliferous plants. 2. *excentrici*, excentric; placed, indeed, within the albumen, but without the axis of the seed, yet so that they cannot touch the walls of the shell; as in Coffee (Coffea), and Asparagus. 3. *peripherici*, peripherical; accumbent on the walls of the shell throughout their whole length, and, consequently, placed both without the axis and without the albumen; as in the Grasses, Pisonia, &c.

c. The size of the embryo varies in different vegetables, very considerably, but admits of the four degrees of measures which were mentioned in treating of the cotyledons*. Indeed, as the cotyledons alone define the figure, so they generally define likewise, the size of the embryo; and, not unfrequently, an embryo which, of itself, is very small, is observed to become very large, by the accession of cotyledonous matter; as in Scytalia sinensis. Thus, from the bulk alone of the cotyledons, we have embryos of the following heads of sizes, viz. 1. *maximi*, very large; as very generally in the Cucurbitaceous plants, the Compound-flowers, the Verticillate plants, the Siliquose, and other, plants. 2. *mediocres*, middle sized; as in the Nightshades (Solanum), and other Luridæ, &c. 3. *parvi*, small; in various Umbelliferæ, the Stellated plants, &c. 4. *minuti*, minute, in most of the mono-

* See page 218.

cotyledonous plants, such as the Orchideæ, the Cyperoideæ, Multisiliquæ, and others*.

d. The number of the embryos is very universally one. Sometimes, however, the number is increased by superfetation. Gærtner once observed two embryos in the seed of the Pinus Cembra: both were in the same cavity of the albumen, but one of them was inverted, the other, as is the usual case in the plants of this genus, was erect. It appears from the descriptions and engravings of some botanists, that a plurality of embryos does sometimes take place in the seeds of Misletoe (Viscum). It is, I think, highly probable that such a plurality of embryos does occur with respect to many other plants; since we know, with certainty, that superfetation may and does take place in the vegetable world, as well as in some families of animals.

e. In regard to its proper parts, the embryo, as I have already observed, consists of three parts, viz. 1. the *Plumula*, 2. the *Scapus*, and, 3. the *Radicula*. I shall now speak, at large, of these in the order in which I have mentioned them.

1. The Plumula, or Plumule, so called from its supposed resemblance to a little feather, is the upper part of the embryo, which (when the seed, after having been placed in a proper situation, and has begun to vegetate) rises upwards, forming all that part of the vegetable which appears above ground. Gærtner defines it "the first bud of the new plant, arising from the scape

* Of all these natural families of plants, and of many others, explanations are given in the course of this work. See, particularly, Part III.

" of the embryo imprisoned in the seed, and ready to " pass afterward into true leaves of the plant". Dr. Grew called this part the Plume*. The English name plumule seems preferable, especially as it is literally the import of the Latin word plumula, which almost all botanists have adopted. Linnæus defines it " the " ascending scaly part of the corcle: " pars corculi " squamosa adscendens†."

Many embryos are destitute of the plumule. This part is very constantly wanting in all the monocotyledonous seeds, except, perhaps, a few of the Grasses. It is, likewise, very often absent from the dicotyledonous seeds; or, at least, it is entirely concealed within the scape. Gærtner denominates these concealed plumules, *immersæ*, or immersed. On the other hand, the *plumulæ emersæ*, or emersed plumules, of the same writer, are always conspicuous, and the radicles are placed in the vertex, yet in such a manner as to remain between the lobes of the cotyledons, and not to come into view except by removing these parts from each other; owing to the narrowness of the place, these kinds of plumules are always compressed, and have conduplicate leaflets, which are either simple or compound.

The simple plumule *(simplex plumula)*, has sessile leaflets in opposite pairs: these leaflets are, 1. *tereti-acuminata*, cylindrical-acuminate. 2. *lineari-oblonga*, linear-oblong. 3. *lanceolata*, lanceolate. 4. *ovato-acuminata*, ovate-acuminate. 5. *convoluto-pel-*

* Dr. Darwin and other writers have adopted this name.

† Philosophia Botanica, &c. p. 54. §. 86.

tata, convolute-peltate; as in Tropæolum. 6. *spiralis*, spiral; as in Gyrocarpus Jacquini.

The compound plumule *(composita plumula)*, on the other hand, supports more than one leaflet upon a common petiole, and these are, 1. *conjugata*, conjugate; either two-paired, or bijugous *(bijuga)*; as in Arachidna, or many-paired *(multijuga)*, as in Juglans, &c. 2. *digitata*, digitate; this is very uncommon, but occurs in the Horse-Chesnut (Æsculus Hippocastanum), and in Lupin (Lupinus). 3. *coacervata*, heaped together; as in Lathyrus, Vicia, and others. These, Gærtner acknowledges, seem properly to belong to the many-paired; but they may be designated by another name, since the leaflets are so closely crowded, and perhaps intermixed with the stipules, that from the minuteness of the parts, they cannot be easily distinguished from each other*.

2. The Scapus, or Scape, is much more frequently wanting in vegetables than is the plumule. Indeed, the greater number of embryos are scapeless, or destitute of this part. Gærtner, however, thinks proper to denominate those embryos caulescent, which are furnished with a very long radicle; especially a radicle which grows somewhat thicker downwards; as in Cestrum, and Persimmon (Diospyros virginiana†); or those in which the cotyledons are separated by a slender stripe from the somewhat swollen capitate radicle; as in Misletoe, Barberry, &c. The same learned writer

* For representations of the plumule, see Plate v. Fig. F. 2. Fig. G. I. Fig. H. 1. Fig. N. Fig. O.

† See Plate v. Fig. N. and Fig. O.

admits, that, in the greater number of embryos, certain limits between the end of the stem, or scape, and the beginning of the radicle, are not given; and that a great portion of almost all those scapes, whilst the business of germination is proceeding, descends into the earth, and is there evolved into a real radicle, or root. Consequently, every part of the embryo, that is placed beneath the cotyledons, may, with propriety, be enumerated among the radicles.

Linnæus and most other writers make no mention of the scape, but divide the embryo (corculum) into two parts only, viz. the plumule, and the radicle. But although the scape be frequently wanting, there does seem to be a propriety in designating by this separate name, a part of the embryo.

3. The Radicula, or Radicle, is by far the most constant part not only of the embryo, but of the whole kernel: for we find it in those seeds which have no other vestige of the embryo. The name of radicle was given to this part of the seed by Dr. Grew, and has been retained by Ludwig, Gærtner, and the greater number of the modern botanists. Linnæus, however, thought proper to designate this part of the embryo by the name of *Rostellum*, and defines it "the simple de-"scending part of the corcle:" "pars corculi simplex "descendens*".

In almost all the seeds which have, hitherto, been examined, we find only a single radicle (*radicula soli-*

* Philosophia Botanica, &c. p. 54. §. 86.

taria) to each embryo. This is the observation of Gærtner, who examined the seeds of 1054 plants, belonging to distinct genera. Some embryos, however, he admits, are furnished with more radicles than one. Thus, three, four, or six together of such radicles *(radiculæ ternæ, quaternæ, senæ)*, properly formed and distinct from each other, are found in the seeds of Rye (Secale), Wheat (Triticum), and Barley (Hordeum), "but in no "other seeds hitherto known*". It is probable, however, that the radicle is less constantly solitary than Gærtner imagined. The fibres, or roots, of this part of the embryo may, in numerous instances, be distinct, but, owing to their minuteness, and cohesion by means of mucilaginous or glutinous matter, they may seem to constitute only a single, undivided body. I think, I have, in one instance, distinctly observed several radicles to a single embryo of the Persimmon.

a. In regard to its figure, the radicle is, 1. *puncticularis*, punctícular; appearing like a mere white point in a kernel, which, in every other respect, is solid; as in the Mosses, and other more imperfect plants. In all other cases, the radicle projects. 2. *tubercularis*, tubercular; but little different from a thicker solid dot or point; as in Pepper (Piper), and Flagellaria. 3. *conica*, conical; arising from the cotyledons with a broad base, and ending quickly in a point; as in Enchanter's-Nightshade (Circæa), and many other plants. 4. *teretiuscula*, roundish. 5. *filiformis*, filiform. 6. *cylindrica*, cylindrical. 7. *fusiformis, vel clavata*, fusiform, or club-

* Gærtner.

shaped; as in Coffee, various Leguminous plants, &c. 8. *capitata*, capitate; as in Zinnia, Viscum, and Berberis. 9. *ovato-globosa*, ovate-globular; as in Cassyta, and in all the minute and globular embryos; for in these the radicle forms the principal part of the embryo, as in Sundew (Drosera), and others. 10. *recta*, straight; as is the case with most short radicles. 11. *curva*, curved; as in most of the long radicles.

b. In regard to its length, the radicle is, 1. *longissima*, very long; that is, longer than the cotyledons; as in Rhizophora, Anguillaria, and others. 2. *æqualis*, equal: that is, as long as the cotyledons; instanced in most of the Umbelliferous plants, and others. 3. *brevis & brevissima*, short and very short; that is, shorter than the cotyledons: instanced in all the monocotyledonous plants, such as the Verticillatæ, &c. in the Persimmon*, &c.

c. The proper situation of the radicle always seems to be at the base of the embryo; but the *relative* situation has a reference to the other internal parts of the seed; and, in an especial manner, to the receptacle of the fruit and seed.

As to the other internal parts of the seed, and especially with regard to the albumen, the situation of the radicle suffers exactly the same modifications, which the embryo itself does: hence radicles are, 1. central. 2. excentric. 3. peripherical. But, from their combination with the cotyledons, a new relation arises amongst these parts, and thence the radicle becomes, 1. *directa*,

* See Plate v. Fig. N. and Fig. O.

direct; continuing to run out in one line with the axis of the cotyledons, whether it be straight or curved; and at the base of the cotyledons does not suddenly take any other course, as in the straight, sickle-shaped, hooked, bowed, and cochleate embryos. 2. *inclinata*, inclined; the axis being joined, at a right or obtuse angle, with the axis of the cotyledons. 3. *reflexa*, reflected; suddenly recurved near the base of the cotyledons, towards their other extremity, and is either accumbent on their sides or chink; as in the conduplicate embryos, especially of the Siliquose and Leguminous plants. 4. *involuta*, involute; constituting the axis of the embryo, about which the cotyledons are so rolled, as to conceal a very large part of the radicle; as in Ayenia, Pomegranate (Punica), and others.

As to the proper receptacle of the fruit or seed, which is a relation of situation of great consequence to be attended to, the radicle is, 1. *supera s. ascendens*, superior or ascending, respecting the apex of the fruit with its point. Those radicles are denominated simply superior, which tend directly upwards, and rise from the highest part of the seed; as in the Umbelliferæ, Asperifoliæ, and others. Those are named ascending, which arise from the base or side of the seed, and tend upwards at their apex; as in Hemp, Corrigiola, &c. 2. *infera s. descendens*, inferior or descending, respecting the base or peduncle of the fruit with its apex. A radicle is strictly named inferior, which, rising from the bottom of the seed, tends directly downwards; as in the Compound-flowers, the Verticillate plants, and others; and it is named descending, when, rising from the highest part of the embryo, it tends towards the base

with its apex; as in Meesia, Marvel of Peru (Mirabilis), and others. 3. *centripetæ*, centripetal; either absolutely or relatively such. In a simple fruit, the former respect the axis, or common receptacle of the seed with their apex; as in Tulip (Tulipa), Tobacco, and others. In a conjugate or many-capsuled fruit, the latter are, indeed, turned to the common axis, but in partial pericarps only respect the internal side; as in Helicteres, Monkshood (Aconitum), Larkspur (Delphinium), and others. 4. The *centrifugæ*, or centrifugal radicles, are, *unilaterales*, unilateral, or one-sided; all respecting one side of the pericarp; or, in a naked seed, the circumference of its horizontal plane; as in Beet (Beta), Goosefoot (Chenopodium), and others: *bilaterales*, bilateral, or two-sided; turned to two directly opposite regions of the pericarp; as in Bog-Bean (Menyanthes trifoliata, &c.), the Siliquose plants, and others: *multilaterales*, multilateral, or many-sided; directing their points to different places, or to every surface of the dissepiments and internal parietes, or walls; as in Cistus Helianthemum, the Cucurbitaceous plants, and others: *vagæ*, vague; which have not the same certain situation in all seeds, but are directed with their points towards different parts; as in Ginger (Zingiber), Water-Lily (Nymphæa), and others.

Such are the various modifications to which the tender embryo is liable. It continues "imprisoned with-" "in its seed", and remains (to use the happy expression of Gærtner) "in a profound sleep", until it is awakened by the approaching germination, and meets the light and air to grow into a plant, similar to its parent. But, even in its encumbered or involved state, the embryo

possesses life, which, however, is not *obviously* active, and by no means of equal duration in all. Or, if we deny to the quiescent and slumbering seed, an inherent principle of life (whatever that may be), we must, at least, admit that its embryon, and other, parts are endowed with a peculiar (and, as yet, incomprehensible) *capacity* for receiving life, from the agency of heat, water, air, and other stimuli*.

HAVING finished the consideration of the various parts of the kernel (I mean the more technical history of these parts, for several important points in their natural history remain to be discussed), I proceed, in the next place, to treat of some other parts of the seed, in general. These parts are, 1. the *Pappus*. 2. the *Coma*. 3. the *Cauda*. 4. the *Ala*: and, 5. the *Crista*.

ALL these are, by Gærtner, denominated accessary parts of the fruits and seeds ("partes fructuum atque seminum accessoriæ"), because they may be present or absent, without injury to the structure of the seed. It would, perhaps, have been better to have treated of these accessary parts, along with the testa, and other integuments of the seed; but, upon the whole, I have thought it more proper to treat of them, in this place, after the consideration of the kernel, especially as the principal of these parts are chiefly instrumental in the propagation of the *ripe* seed.

1. THE Pappus†, or Aigrette, is a sort of feathery or hairy crown, with which many seeds, especially those

* See page 105.

† In the Latin language, this word has the following significations, viz. a grand-sire, an old man, thistle-down, and several others. In this last sense, it is employed by Lucretius (Lib. iii. l. 387).

of the Compound-flowers, are furnished, evidently intended for the great business of the dissemination or dispersion of the seed, to a considerable distance.

THE word pappus is commonly translated Down*: "but hence, as Dr. Martyn observes) arises a confusion "between this and the *lanugo* or *tomentum* on the surface of leaves, &c.", which, both in Britain and the United-States, is generally called down. Some writers translate this word by Feather, but there are objections to this word. The French call it aigrette. "The ladies have "adopted that term: why may not we?"

LINNÆUS explains the pappus to be "a feathery "or hairy flying crown to the seed:" "Corona (semi-"nis) pennacea, pilosave volitans†".

DIFFERENT kinds of pappus are enumerated by the botanists: Thus we have, 1. *pappus sessilis*, a sessile aigrette; or a down placed immediately upon the seed, in the form of a crown; as in Hawkweed (Hieracium), in Goats-Beard (Tragopogon), and others. 2. the *pappus stipitatus*, or stipitate aigrette, is supported on a thread, called the stipe‡, and elevated by it considerably above the vertex of the seed; as in Common Dandelion (Leontodon Taraxacum), and many others.

THE pappus is likewise, 1. *capillaris*, or capillary, and, 2. *plumosus*, or feathery. The capillary aigrette,

* Thus Sandys:

"Like scatter'd down, by howling Eurus blown
"By rapid whirlwinds from his mansion thrown".

See, also, the lines from Thomson, in page 241.

† See Philosophia Botanica, &c. p. 54. §. 86.

‡ See page 28.

or pappus, is simple, having the hairs undivided* ; as in Silk-Cotton-tree (Bombax pentandrum), Groundsel (Senecio), Golden-rod (Solidago), and various other Compound-flowers. The feathery aigrette, on the contrary, is not simple, but branched, like a feather ; having, in other words, setaceous or chaffy rays, with lateral hairs, which are always capillary.

Other species of pappus are enumerated, such as, 1. *aristatus*, awned ; having one, two, three, and, sometimes more, short rigid rays, often hooked backwards ; as in Bidens. 2. *stellatus*, stellate ; consisting of five filiform and attenuated and spreading rays ; as in Geropogon. 3. *spinosus*, thorny ; having acinular and pungent rays ; as in Zinnia. 4. *setaceus*, differing from capillary (above mentioned) only in the greater rigidity, and more numerous teeth ; as in Chrysocoma. 5. *ciliatus*, ciliate ; between setaceous and feathery. 6. *lanatus*, woolly ; in which the vertex of the seed is crowned with a white ring, formed of a very short and dense wool ; as in Cineraria glauca.

b. In regard to its duration, the pappus is, 1. *persistens*, permament ; continuing with the seed ; and, of course, this species of aigrette is peculiarly favourable to the dispersion of seeds. 2. *caducus*, *s. fluxilis*, caducous, or very temporary : this is less common than the other, and is principally given to the larger and heavier seeds, as those of Thistle (Carduus), Cotton-Thistle (Onopordum), and others : it is, however, found in the smaller seeds also, as in those of Sow-

* Although the capillary pappus is very slender, like a human hair, it is, nevertheless, marked with very minute teeth, which are sometimes nearer, sometimes more remote from each other.

Thistle (Sonchus), Lettuce (Lactuca), and others. By some writers, this last-mentioned kind of aigrette is denominated *pappus deciduus*, or deciduous aigrette.

A KNOWLEDGE of the aigrette is of essential consequence in the study of botany. Linnæus very generally employs the many varieties which obtain in this minute and delicately-organized part of the plant, in discriminating the different genera of the plants of his class Syngenesia. Gærtner has, certainly, very unjustly denied Linnæus's attention to the pappus. Vaillant, a long time ago, always attended to this part of the fructification in drawing the characters of his genera; and it is certain, that he examined and defined it, with uncommon care: "Whence (says Gærtner) his genera are "much preferable to those established by Linnæus".

THE aigrette, as I have already observed, is evidently intended for the great business of the dissemination or dispersion of the seeds. This is, indeed, one of the wonderful contrivances employed by the liberal hand of nature for distributing her vegetable productions over the surface of the earth. There can be little doubt, that many species of plants, particularly among the Compound-flowers, owing to their being supplied with the aigrette, are now the common inhabitants of many parts of the world, in which, originally, they were unknown.

THOMSON (who has very happily been called the Naturalist's Poet) has so beautifully, and at the same time so philosophically, alluded to the dispersion of plants by means of the apparatus which I am consider-

ing, that I cannot refrain from concluding this account of the aigrette, with his lines on the subject:

——————— A fresher gale
" Begins to wave the wood, and stir the stream,
" Sweeping with shadowy gusts the fields of corn;
" While the quail clamours for his running mate.
" Wide o'er the thistly lawn, as swells the breeze,
" A whit'ning shower of vegetable down
" Amusive floats. The kind impartial care
" Of Nature nought disdains: thoughtful to feed
" Her lowest sons, and clothe the coming year,
" From field to field the feather'd seeds she wings".

SUMMER. l. 1639-1648.

2. THE Coma is very nearly related to the pappus; for, like it, it is formed of hairs which are placed upon the vertex of the seed, and collected into a bundle. According to Gærtner, it differs from a pappus, because in the coma, the hairs derive their origin from the shell of the seed, and not from the proper calyx of the flower; and because all the comate seeds are furnished with a true pericarp; as in Willow-herb (Epilobium), and others. These, therefore, according to the same botanist, are improperly considered as pappous seeds.

3. THE Cauda, or Tail, resembles a slender stipe, proceeding from the vertex of the seed, hairy from the base to the apex, and, in the naked seeds, produced from the persisting style of the ovary; but in the covered seeds, from the testa, or shell. In both these cases, the cauda is much longer than the seed; as in Virgin's Bower (Clematis), in Pasque-flower (Anemone Pulsatilla), &c.

THE hairy tail, which proceeds from the base of the ovary, as in Cat-tail (Typha), and Plane-tree, or Button-wood (Platanus occidentalis) is to be accounted a mere and simple peduncle of the fruit.

4. THE Ala, or Wing, is a broad flexible and membranous expansion, fixed to the vertex, back, or sides of certain fruits and seeds, and thus facilitating their dispersion. When it occupies the vertex and back, it is especially denominated a wing: but when it surrounds the sides, it is called a Margin *(Margo)*. Linnæus thus defines the wing: "*Ala*, membrana, qua "volitante disseminatur, affixa semini*".

SEEDS that are furnished with wings are, 1. *unialata*, one-winged; as in Mahagoni (Swietenia), and others. 2. *trialata*, three-winged; as in Moringa. To this head may, also, be referred the seeds of Rhubarb (Rheum), and Buck-wheat. 3. *quadrialata*, four-winged. I believe we have not, hitherto, discovered any examples of four-winged seeds, except in the genus Combretum.

A membranous margin *(Margo membranaceus)* is not uncommon in seeds, and occurs very differently formed. Thus, it is, 1. *planus & integer*, flat and entire; as in Allamanda, and others. 2. *apice & basi emarginatus*, emarginate, at the base and apex; as in Lilac (Syringa), &c. 3. *cymbiformis*, boat-shaped; as in Marigold (Calendula), &c. 4. *bullatus*, bullate; appearing like blisters; as in Cynoglossum omphalodes. 5. *in dorsum reflexus*, reflected upon the back, and forming spurious cells, as in Arctotis, &c.

* Philosophia Botanica, &c. p. 54. §. 86.

The preceding terminology applies principally to seeds. But pericarps, also, are furnished with the ala, or wing. Such pericarps have received the following names, viz. 1. *monopterygia*, one-winged; being furnished with only one wing; as in Ash (Fraxinus), and others. 2. *dipterygia*, two-winged; as in the conjugate fruit of Maple (Acer), and in Halesia diptera, an American vegetable. 3. *tripterygia*, three-winged; as in Begonia, &c. 4. *tetraptera*, four-winged; as in the beautiful Halesia tetraptera, and in Tetragonia. 5. *pentaptera & polyptera*, five-winged, and many-winged; as in Guaiacum, and in Crown-Imperial (Fritillaria), and others.

The membranous margin is not uncommon in some of the more compressed pericarps; as in Shepherds-purse (Thlaspi), and others: but in seeds it is much more common.

5. The Crista, or Crest, is very nearly allied to the wing, but is narrower, less flexible, and formed of a coriaceous or cork-like matter, and always placed on the back of fruits.

The crista has received different names. Thus, it is, 1. *serrata*, serrated. 2. *laciniata*, laciniated. 3. *dentibus incisa*, toothed. 4. *crispata*, curled; as in Daucus, and others.

Besides the preceding, Gærtner has enumerated other, accessary parts of fruits and seeds: such as, 1. *Rostrum*, a Beak; generally proceeding from the peristing style, as in Stone-crop (Sedum), Hellebore (Helleborus), and others. 2. *Costæ & Juga*, Ribs and Ridges;

elevated, rounded, or muricated furrows, placed on the back of seeds or pericarps, and separated from each other, by flattish intermediate spaces; as in Horn-Beam (Carpinus), the Umbelliferous plants, and others. 3. *Strophiola*, Strophioles; these are fungous, glandular or callous epiphyses, generally of an oblong form, and to be found only upon the ventral side of the seed; as in Wild-Ginger, or Asarabacca (Asarum canadense), and others. 4. *Spinæ*, or Thorns. 5. *Glochides*, Barbs. 6. *Verrucæ*, or Warts. 7. *Squamæ*, Scales. 8. *Pubes*, Pubescence. 9. *Pruina*, Hoariness, and others.

Most of these accessary parts of the seed, and pericarp, have already been mentioned, in treating of the different kinds of fulcres, as Linnæus calls them*. It is unnecessary, therefore, to say any thing further on the subject, in this place.

Beside the semen, or seed, properly so called, two other terms are referred to this general head, by Linnæus: these are, 1. the *Nux*, and, 2. the *Propago*.

1. The Nux, or Nut, is a seed covered with a shell. Linnæus thus defines it, "Semen tectum epidermide osseo†". Gærtner defines it "a hard conceptacle, either not opening at all, or, if it do open, never separating into more than two valves". The following account of the nut is principally taken from this truly meritorious author.

The nut has an affinity, on the one hand, with capsules, and on the other hand, with drupes. Sometimes,

* See pages 82-91. † Delineatio Plantae.

it is even referred to the naked seeds. From the capsule, it differs in the total want of valves, and in the base often having a scraped or filed appearance to some distance. From the drupe, it differs in the manifest nakedness of the putamen, or shell; or if there be a rind, in the incomplete opening at the apex. Lastly, it differs from the naked seeds in the remarkable thickness of the putamen; the easy separation of it from the kernel, and the manifest umbilical vessels, placed within the cavity of the putamen; as in Cotton-grass (Eriophorum), many of the Asperifoliæ, &c.

a. In regard to its integuments, the nut is, 1. *nuda*, naked. (By far the greater number of nuts are naked, or, at least, clothed with a cuticle which is hardly discernible). 2. *glabra*, smooth. 3. *splendens*, shining. 4. *rugosa*, wrinkled. 5. *subpubescens*, somewhat pubescent. 6. *corticata*, corticated; covered with a rind *(cortex)*: this rind is either membranous, and frequently extended into a wing, or ribs, as in Pine, Houndstongue (Cynoglossum), and others; or coriaceous and thick, as in Juglans. The latter are nearly allied to dry drupes. 7. *involucrata*, involucred. Nuts are more generally supplied with an involucre than any other species of pericarps; as in Chesnut, Beech, Yew, Juniper, Hazel, Oak, and others*.

b. In regard to its consistence, the nut is, 1. *sicca*, dry. 2. *firma*, firm. 3. *dura*, hard. 4. *coriacea*, coriaceous; as in Chesnut, and others. 5. *crustacea*, crustaceous; as in many of the Rough-leaved plants.

* Several of the seeds here denominated nuts, are referred by Linnæus, to other heads See page 194, &c.

6. *cavernoso-coriacea*, cavernose-coriaceous; as in Cashew (Anacardium), and in Acajuba. 7. *ossea*, bony; as in Walnut, Hazel, &c. 8. *lapidea*, stony; as in Myosotis, and others.

c. In the nut, there is no spontaneous opening before the germination of the seed; nor does the number of the valves, in any instance yet known, exceed two. The English Walnut (Juglans regia) alone has a manifest suture. Trapa alone opens with a hole at the vertex. Many of the nuts open at the base, or at their insertion, with a round aperture, or chink; as in Lycopsis arvensis (Small Bugloss), and others.

d. In regard to its internal fabric, the nut is, 1. *simplicissima*, very simple. 2. *unilocularis*, unilocular, or one-celled; as in by far the greater number of nuts. 3. *bilocularis*, bilocular, or two-celled; as in Cerinthe and Trapa. Very few nuts are two-celled. 4. *trilocularis*, trilocular, or three-celled; as in Beech and Oak. 5. *semiquadrilocularis*, half-four-celled; as in Chesnut.

From this view of the subject, it is evident, that nut is a pretty comprehensive term, embracing a considerable variety of seeds, such as those of the Chesnut, Beech, Chinquepin, Walnut and Hickery, Hazel, Oak,* Juniper, Yew, Oil-nut†, and others.

2. Propago is the name of the seed of the Mosses. It is thus defined by Linnæus: "Semen *Musci* decor-

* The cup of the acorn is denominated, by late writers, *cupula*.

† A new Pentandrous genus of plants, allied to Nerium. It is a native of Pennsylvania, Virginia, and other parts of the United-States.

" ticatum, detectum 1750*". The Swedish naturalist supposed, that these seed differed from other seeds in having a naked corcle (embryo), without bark or cotyledons. He informs us, that he made this discovery in 1750. A few years after this period, David Meese asserted, that the seed of the Mosses are furnished with their proper cotyledons. The industrious Hedwig, as has already been observed†, also asserts, that the seed of this great family of plants are, like those of other plants, supplied with cotyledons. Gærtner admits the existence of acotyledonous plants, and refers to this head the Mosses‡. By this author, the propago is considered as a species of gemma, or bud, perfectly simple, and destitute of true leaflets, assuming different forms, sometimes entirely naked, and sometimes shut up in a bark-like case; which, at length, separates spontaneously from its parent, and is scattered like a seed. The bulb-like granules (" grana bulbiformia") of G. C. Oeder§ are referred to this head.

I RESUME the consideration of the seed, in general.

a. IN regard to the number of the seeds, this is a very variable circumstance in different vegetables: 1. Some plants have only a single seed‖. This is the case with the Sea-Pink (Statice Armeria), and Bistort (Polygonum Bistorta). 2. Some have two seeds, as Woodroof** and the Umbelliferous plants. 3. Some have three, as Spurge (Euphorbia). 4. Some have four, as the

* Philosophia Botanica, &c. p. 54. §. 86. " *Propagines Muscorum* sunt semina " destituta tunica & cotyledonibus, adeoque nudi corculi Plumula, ubi Rostellum " infigitur calyci plantæ". Ibid. p. 57. §. 88.

† See pages 210, 211.

‡ See page 210. See, also, Part III. Class XXIV. CRYPTOGAMIA.

§ Elementa Botanicæ, &c. Pars prior. p. 35. Hafniæ · 1764.

‖ That is, in each pericarp.

** Asperula odorata.

greater number of the Lip-flowers of Tournefort, and the Rough-leaved plants of Ray. 5. Some have many seeds, as Ranunculus, Anemone, Poppy, Lobelia, Ludvigia, Gerardia, and others.

The fertility of nature in the production of seeds is almost incredible, and is a circumstance well calculated to display the unbounded liberality of nature and the immense quantity of life that may spring from a solitary embryo. A single stalk of Indian-Corn (Zea Mays) produced in one summer 2000 seeds: in the same period, a plant of Elecampane (Inula Helenium) produced 3000 seeds: the Common Sunflower (Helianthus annuus) 4000: the Poppy, 32,000. A single spike of Cats-Tail (Typha) produced 10,000 seeds, and upwards. A single capsule of the Tobacco was found to contain 1000, and one of the White-Poppy (Papaver somniferum), 8000, seeds. Each capsule of the Vanilla contains from 10,000 to 15,000, seed! Mr. Ray informs us, from actual experiments made by himself, that 1012 Tobacco-seeds are equal in weight to one grain; and that the weight of the whole quantity of seed in a single stalk of Tobacco, is such, that the number of seeds, according to the above-mentioned proportion, must be 360,000. The same learned naturalist estimates the annual produce of a single stalk of Spleen-wort (Asplenium) to be upwards of one million of seed. Dr. Woodward has calculated, that a single Thistle seed will produce at the first crop, 24,000 seed; and, consequently, five hundred and seventy-six millions of seeds, at the second crop!! Well might Virgil say, that the Thistle becomes "dreadful in the corn-fields*".

* See page 121., for the quotation from the Georgics.

Our admiration cannot but be excited by this fertility. Yet it is more wonderful, as has been observed*, that in some plants such a prodigious number of ovules can be fecundated by very few stamens; and that in other plants, even a very moderate quantity of ovules cannot be fecundated by a numerous set of stamens. It is worth observing, in this place, that very generally plants which are distinguished for the number of their seeds, are those which have the fewest stamens, or anthers. Thus Vanilla has but one anther, and the Tobacco five; whilst, on the other hand, among the Polyandrous plants (most of which have many stamens), there are not a few vegetables, which are scarcely equal to the fecundation of a single ovule†. These facts must lead us to believe, that the fecundation of seeds is owing more to the *quality* or peculiar virtue of the pollen, than to the mere *quantity* of this fecundating powder. Thus, I have found, that the pericarp of the Crown-Imperial (Fritillaria imperialis) swelled as completely from the influence of only one anther, as from the whole number, which is six, of those male organs of generation, in this vegetable. These facts must, likewise, show us (and it is a circumstance fortunate for mankind), that every vegetable ovule is not destined by nature, to give rise to a future progeny. The same remark, unquestionably, applies to the animal, as well as to the vegetable, world. Millions of embryos preexist, but never are evolved into active life.

* By Gærtner.

† It must, however, be remembered, that the Poppy is, at once, remarkable for the number of its stamens and its seed; and that among the *Orchides*, many of which have only a single anther, there are not a few individuals, which very rarely do furnish us with prolifick seed.

As the number of the seeds is so extremely variable in vegetables, it must be evident, that genera constructed merely from this quality of the fructification, must be artificial and precarious. Thus, Gleditsia triacanthos (Honey-Locust) has a legume with several seed; whilst another species (Gleditsia monosperma) has only a single seed in its legume. Many other instances, of a like kind, might be mentioned. Nay, even in the same species, the number of the seed is often indefinite. Thus, in Persimmon (Diospyros virginiana), we find the fruit with one seed, with two, three, four, five, six, seven, and eight seed. It must be confessed, however, that in many families and natural genera of vegetables, the number of the seeds is pretty constant and invariable.

b. In regard to its figure, the seed is, 1. *subrotundum*, roundish. 2. *ovatum*, ovate. 3. *oblongum*, oblong. 4. *scobiforme*, scobiform, or saw-dust-like; resembling saw-dust. 5. *filiforme*, filiform. 6. *turbinatum*, turbinate. 7. *clavatum*, club-shaped. 8. *angulatum*, angular. 9. *cylindraceum*, cylindrical. 10. *triquetrum*, triquetrous. 11. *acerosum*, acerose. 12. *teres*, columnar. 13. *ellipticum*, elliptical. 14. *lunulatum*, crescent-shaped. 15. *cordatum*, cordate. 16. *reniforme*, reniform. 17. *orbiculatum*, orbicular. 18. *globosum*, globular. 19. *arillatum*, arilled; furnished with an aril*. 20. *planum*, flat. 21. *hinc planum, inde rotundum*, flat on one side, and round on the other. 22. *hinc rotundum, inde angulatum*, round on one side, angular on the other. 23. *compressum*, compressed. 24. *gibbum*, gibbous. 25. *angulis membranaceis*, with membranous angles. 26. *acuminatum*, acuminate. 27. *obtusum*, obtuse. 28.

* See page 196, &c.

rostratum, rostrate. 29. *erectum*, erect. 30. *marginibus membranaceis*, with membranous margins. 31. *emarginatum*, emarginate. 32. *caudatum*, tailed; terminated by a naked or feathery filament. 33. *carinatum*, keeled. 34. *squamatum*, scaly.

c. SEEDS, it is hardly necessary to observe, vary remarkably in size. It may, however, be remarked, that Gærtner has established four heads of sizes of the seed, viz. 1. *magnum*, large; not smaller than a walnut, or which exceeds a geometrical inch; whether it be extended in thickness, as in Lontarus maldivica* and Cocoa nut (Cocoa); or in length, as in Rhizophora. 2. *medium*, middle-sized; between an inch and two lines†; neither larger than a Hazel-nut nor smaller than a Millet-seed. 3. *parvum*, small; exceeding half a line; but not greater than two lines, contained within the limits of the seeds of Bell-flower (Campanula), or a Poppy. 4. *minutum*, *s. exile;* minute; smaller than the preceding, and often like dust or powder, as in Chara, in the Ferns, in the Mosses, &c.

d. IN regard to its surface, the seed is, 1. *glabrum*, smooth; having no conspicuous inequalities or splendor on its surface; as in Radish, Cabbage, and others. 2. *lævigatum*, polished, smooth and shining; as in Amaranthus, Sapota, &c. 3. *lucidum*, *s. splendens*, lucid or shining; the surface shining, but not perfectly smooth; as in Corn-Gromwell (Lithospermum arvense), &c. 4. *striatum*, striated; having either longitudinal

* The pericarp of this plant (which is a berry) is frequently a foot and a half in thickness.

† The line is the twelfth part of an inch.

streaks, as in Hemlock and other Umbelliferae, or transverse or oblique streaks; as in Exacum; or radiated ones, as in Tradescantia. 5. *sulcatum*, furrowed; marked with thick streaks, either simple or branched; as in Fool's Parsley, (Æthusa Cynapium), Ipecacuanha (Psychotria), and Pimpinella agrimonoides*. 6. *cancellatum*, latticed; having the longitudinal streaks, or furrows, decussated by transverse and generally narrower ones; as in Glaucium, Argemone, Onopordum, &c. 7. *reticulatum*, reticulated; differing from the former in the irregularity only of the streaks; as in Pennywort (Hydrocotyle), &c. 8. *scrobiculatum*, scrobiculate; marked with rather large pits, distant or contiguous; as in Euphorbia Tithymalus. 9. *punctatum*, dotted, or punctate; either excavate-punctate (*excavato-punctatum*), or elevate-punctate (*elevato-punctatum*), with the dots disposed in series, or irregular. Such seeds are common in the Luridae, and other natural families. 11. *apiculatum*, apiculate; rough, with very short and frequently capitate bristles; as in Drosera. 12. *tuberculatum*, tubercled; rough with thicker elevated dots, or tubercles; as in Hydrocarpum. 13. *papillosum*, papillous; covered with flexible scales, or fleshy tubercles; as in Eryngo (Eryngium), and in Codon. 14. *vermiculatum*, vermiculate; marked with elevated serpentine streaks, or a species of foreign letters; as in Balsam-apple (Momordica), &c. 15. *marginatum*, marginate; either thickened at the margin; as in Cucurbita, or extenuated at the margin

* To this head belong the following, viz. 1. *costatum*, ribbed, and, 2. the *malendinaceum*, molendinaceous, or mill-stone-like, seed, so named from the thickness or breadth of the dorsal furrows; as in Caucalis, &c.

(marginaceo-extenuatum), as in Allamanda. 16. *rugosum*, wrinkled; rough with tubercles, streaks, and pits irregularly intermixed; as in Aconitum, &c.

e. In regard to their colour, there is a very considerable variety in the seeds of plants. This is the more remarkable, because the seed is the only part of the vegetable which, without having received the free access of light, is decorated with fine colours. It is, moreover, to be observed, that the colours of seeds are such as rarely occur in the coloured parts of flowers, but, on the contrary, the most generally prevailing colours of the flower are extremely uncommon in seeds.

The following are the principal colours of different seeds, viz. 1. *melinum*, honey-coloured. 2. *rufescens*, *reddish*. 3. *helvolum*, pale-red. (These three are the most common colours of seeds, and the least common in flowers). 4. *ochraceum*, ochrey. 5. *ferrugineum*, rusty. 6. *castaneum*, chesnut-coloured. (These, after reddish, are the most frequent colours of seeds, and are hardly ever observed in flowers). 7. *nigrum*, *atrum & anthracinum*, black and different varieties of black. These are colours nearly peculiar to seeds; for we have no instances of flowers entirely black, though there are some that have black spots. I may add, that we have many instances of black or blackish pericarps; as in Podalyria australis, Cassia marilandica, and others. 8. *fuscum*, brown. 9. *testaceum*, tile-coloured. 10. *spadiceum*, bay. (These are common in the seeds and bark, but very unusual in flowers). 11. *album*, white. 12. *lacteum*, milky. 13. *niveum*,

snowy. (These are more frequently to be met with in flowers than in matured seeds: yet seeds, before maturity, are, very generally, white. 14. *rubrum*, *coccineum*, & *rutilum*, red, scarlet or crimson, and fiery: these colours are very common in flowers, but much rarer in seeds. In Gloriosa, however, in Abrus precatorius, and in others, we meet with fine scarlet and other red seeds. 15. *roseum*, rosy. This is a very frequent colour in flowers, but very rarely observed in seed. In Pomegranate, however, we have an instance of it. 16. *cæruleum*, blue. Blue seeds are extremely rare, but they do occur in Croton cyanospermum, and in a variety of Kidney-Bean (Phaseolus vulgaris). 17. *subcærulea*, or somewhat blue, and *plumbeolivescentia*, lead-livid, seeds are met with in Zingiber, and some other plants. 18. *viride*, green. (Although green is so predominant a colour in the vegetable world, it is extremely uncommon in seeds. In some plants, however, as in Adonis vernalis, and in Yellow-Balsam, or Touch-me-not (Impatiens noli me tangere*) grass-green seeds do occur. Yellowish-green *(lutescenti-viridia)* seeds occur in different species of Bird'sfoot-Trefoil (Lotus), and others. 19. *variegatum*, variegated; as in Lathyrus, Phaseolus, &c.

All the preceding colours, not to mention others, are assumed by seeds, when they are ripe. Colour is, therefore, very generally considered as a proof of the maturity of seeds. It is to be observed, however, that the seeds of many vegetables remain colourless, during the whole term of their life. Moreover, the colour

* Balsamina Noli tangere of Gærtner.

frequently varies from the influence of culture, and by age is often changed from a paler to a darker, becoming, from straw-coloured, reddish; from reddish, rust-coloured; and, from rust-coloured, brown. "Hence (as Gærtner observes) colour can neither be "taken for a certain sign of maturity, nor for a distinctive specifick mark: but it serves to distinguish a "seed from the neighbouring parts, and especially from "Pyrenes*". Our author considers that coat as the proper outermost integument of the seed, which is distinguished, by its peculiar colour, from the neighbouring coats.

f. In regard to its consistence, the seed is, 1. *exsuccum*, juiceless. 2. *duriusculum*, hardish. 3. *amygdalino-carnosum*, almond-fleshy; a seed retaining the impression of the nail. 4. *fungosum s. suberosum*, fungous, or cork-like; a seed which can be opened by scratching. 5. *coriaceum*, coriaceous; which can be cut with a knife. 6. *crustaceum*, crustaceous; which can be broken by the fingers. 7. *nucamentaceum s. osseum*, nucamentaceous or bony, which can hardly be broken in pieces between the teeth. 8. *baccatum*, berried.

g. For particular information concerning the situation of the seed, I must refer the reader to the work of Gærtner. I shall only observe, that the situation of these parts is of great consequence in defining the limits of the genera of plants; and is of the highest importance in a philosophical view of the seed; for Gærtner

* Pyrenes, according to Gærtner, are nothing but partial putamens, or the bony coats of single cells, often again divided into partial chambers, entirely separated from the neighbouring ones which resemble them. But for more minute information concerning these parts of the pericarp, I must refer the curious reader to Gærtner's work, *De Fructibus*, &c. &c.

has shown, that the situation of the seed is the most constant of all its extrinsic qualities. This botanist determines the situation, partly from the figure, partly from the insertion of the seed, and, in part, from the direction of the radicle of the embryo.

As Linnæus has denominated the pericarpium, the "ovarium fœcundatum", or fecundated ovary, so he denominates the seed, the "egg of plants*". To these analogical terms, there can be no particular objections.

A KNOWLEDGE of the pericarp and seed is of the utmost importance in the study of botany: I mean in the methodical distribution of plants, and in investigating their affinities to each other. In a philosophical and physiological point of view, the dignity of these parts will be immediately seen and acknowledged. We shall afterwards see, that Linnæus almost always attends to these parts of the fructification in drawing the generick character of vegetables. By other botanists, the fruit has been deemed of still more importance. Thus, Rivinus has founded the orders of his system upon the fruit. The great Tournefort has done the same. Camelli constructed a method upon the valves of the fruit: and although Linnæus has declared, that in determining the genera of plants, the flower ought to be greatly preferred to the fruit, his opinion on this subject has not received the sanction of *all* the botanists since his time. Thus, Gærtner is of opinion, that for the purpose I have mentioned, the two parts in question are

* See Philosophia Botanica, &c. p. 92 §. 146. "Omne vivum ex ovo; per "consequens etiam vegetabilia; quorum Semina esse *Ova*, docet eorum Finis, so- "bolem parentibus conformem producens". Ibid. p. 88. §. 184.

nearly equally entitled to attention, "for Nature (he observes) "has made flowers and fruits equal in dig- "nity". This is, unquestionably, the case.

SEVERAL important circumstances in the history of the seed are necessarily delayed to the Second Part of this work. This, however, appears to be the most proper place to speak of the DISSEMINATION, DISPERSION, or MIGRATION OF SEEDS, and of their GERMINATION.

A. I. OF THE MIGRATION OF SEEDS.

NATURE has employed various modes for effecting the diffusion of the seeds of vegetables over the surface of the earth. The principal of these modes are the following, viz.

1. RIVERS, and other running waters. The seeds of many vegetables are carried along by rivers, and torrents, and the ocean, and are frequently conveyed to the distance of many hundred, or thousand, miles from the countries in which they were originally placed. In this manner, many of the plants of Germany are conveyed to the shores of the sea in Sweden; various plants of Spain and France are carried to the shores of Britain; and the plants of Africa and Asia are often conveyed to the shores of Italy. Sir Hans Sloane has given an account of four kinds of fruits,

which are frequently thrown, by the sea, upon the coasts of the islands of the northern parts of Scotland. These seeds, or fruits, were Mimosa scandens; Horse-eye-bean (Dolichos pruriens), Ash-coloured Nickar-tree (Guilandina Bonduc), and the "Fructus orbicularis sulcis nervisque distinctus*" of Caspar Bauhin. All these are American vegetables†, and three of them were known by Sloane to be natives of Jamaica. These and several other kinds of seeds, which are, likewise, found abundantly upon the coast of Norway, were thought by our author to have been brought by currents, through the Gulph of Florida, into the North-American ocean. Dr. Tonning has mentioned several other seeds which are annually thrown upon the coasts of Norway: such as those of Cashew-nut (Anacardium occidentale), Bottle-gourd (Cucurbita lagenaria), Dog-wood-tree (Piscidia Erythrina), and Cocoa-nut (Cocos butyracea). These are often in so recent a state, that they would, unquestionably, vegetate, were the climate favourable to their growth and existence. And, doubtless, they are frequently carried to countries in which they do vegetate as well as in the countries where they were originally placed, by the hand of the Creator.

Dr. Darwin observes, that the fact of the emigration of these seed is "truly wonderful, and cannot be "accounted for but by the existence of under currents "in the depths of the ocean; or from vortexes of water "passing from one country to another through caverns

* Strychnos colubrina? of Linnæus.

† They are, likewise, natives of the East-Indies.

" of the earth". It does not, however, I think, seem necessary to adopt this conjecture of the English poet; but I can, with great pleasure refer my readers to his pretty lines on the voyage of Cassia from the " brine-" less tides" of Lake-Ontario, to the coasts of Norway*.

2. WINDS. I have already taken notice of the dispersion of plants by means of the winds†. It is hardly necessary to say any thing further on the subject, in this place. I may observe, however, that the vegetables which are carried by the wind, are either winged as in Fir-tree (Pinus Abies), in Trumpet-flower, (Bignonia radicans), Tulip-tree (Liriodendron Tulipifera), Arbor vitæ (Thuya occidentalis), and some of the Umbelliferae, not to mention many others: or they are furnished with an aigrette, as in the plants formerly enumerated, when treating of this part‡; or they are placed within a winged calyx, or pericarp; as in Statice Armeria, Ash, Maple, Elm, Log-wood, Woad (Isatis); or, lastly, they are contained within a swelled calyx or seed-vessel; as in Ground-cherry (Physalis viscosa, &c.), Melilot (Trifolium Melilotus), Bladder-nut (Staphylea trifolia), Bladder-sena (Colutea arborescens), Heart-seed (Cardiospermum), and many others.—With respect to all these vegetables, it is certain, that, owing to the peculiar structure of their pericarps or seeds, they are very extensively diffused over the surface of the earth; and in this way, there can be no doubt, that we are to explain the circumstance of many of these ve-

* The Loves of the Plants. Canto iii. l. 411 418.

† See pages 242, &c. ‡ See pages 239-241.

getables being found in remote and opposite parts of the globe, as in North-America and Asia. Thus, the Erigeron canadense, or Canadian Flea-bane, which was brought to Europe, in the seventeenth century, has spread over a great part of that continent; and the Common-Dandelion is often seen growing upon the highest towers of towns and cities. This last-mentioned vegetable is not, I think, a native of North-America, but it has already been carried to very distant parts of the continent, and, in a few years, will be as extensively diffused as any of our vegetables.

3. Birds and other animals are no mean agents in the dissemination of vegetables. Birds, in particular, are greatly instrumental in this business. They swallow the seeds, which they discharge entire, and thus scatter them, with their excrements, over the face of the earth. In this manner, the seeds of Common-Misletoe, and those of some species of Loranthus, are deposited in the crevices of the barks of vegetables, where they grow, and continue to receive their nourishment. In the United-States, the former of these vegetables is very frequently found growing, as a parasite, to the branches of the Sour-Gum (Nyssa integrifolia), the Apple-tree, and others. Different species of Turdus, or Thrush, are especially concerned in its diffusion. Loranthus americanus, which is a native of the West-Indies, is deposited upon the branches of the most lofty trees, particularly Coccoloba grandifolia; where it is most firmly fixed, and, unquestionably, receives its nourishment from the supporting vegetable*. Rum-

* Professor N. J. Jacquin.

phius assures us, that a particular species of Pigeon is very instrumental in disseminating the true Nutmeg in the East-India islands. It is in this way, that the Poke (Phytolacca decandra), the berries of which are eaten by the Robin (Turdus migratorius), the Thrush (Turdus rufus), the Wild-Pigeon (Columba migratoria), and many others, appears to have been so extensively diffused through North-America. The Rev. Mr. Robinson, in his *Natural History of Westmoreland and Cumberland*, has very particularly mentioned a thick grove of Oak-trees, which were known to have sprung from the acorns that had been planted by a great number of crows, about twenty-five years before. Of the North-American birds, that are known to us, no one, I believe, is more instrumental in planting groves of Oaks, and other trees, than the Crested-Crow, or Jay-bird (Corvus cristatus), which is extremely provident in laying up great stores of acorns, and other seeds, in the holes of fence-posts, and other similar places. There seems to be little doubt, that the very regular growth of many of our forest-trees along the courses of fences, is to be ascribed, in part, to the agency of this and other species of birds, as well as some species of quadrupeds.

Besides the birds, many other animals have been greatly instrumental in the dispersion of the seeds of vegetables. Squirrels, Rats, and other animals, suffer many of the seeds which they have devoured to escape, and thus disseminate them. Our Indians are of opinion, that the squirrels plant *all* the timber of the country. This I do not suppose; but it is certain, that they contribute not a little to this end, by deposit-

ing in the earth, for food, store-houses of various kinds of nuts and seeds, such as those of the Chesnut, Oaks of different kinds, Walnuts and Hickery-nuts, the seeds of the Common Dogwood (Cornus florida), and many others. Immense numbers of these seeds, even though there were not a great destruction of the squirrels, would vegetate, and grow to a good size. But as there is annually a prodigious destruction of these quadrupeds, whole forests cannot but spring from the stores which they have laid up. It has, indeed, been asserted*, that the Striped Dormouse, or Ground-Squirrel (Sciurus striatus), previously to depositing, in the earth, its winter food, takes the precaution of depriving "each kernel of its germe, that it may not sprout". Were this assertion founded in truth, it would constitute one of the most interesting facts in the history of animal instinct, or reason. But, although the little quadruped of which I am speaking, may, on many occasions, deprive the kernel of its germ, or embryo (not, I presume, to prevent its growth, but because the embryo, in almost all seeds, has a very delicate and agreeable taste), it is certain, that, in the greater number of instances, no such mutilation of the seed is accomplished, and that, therefore, innumerable seeds, that have been planted by animals, may, and actually do, grow into trees, and other vegetables.

Animals contribute to the dispersion of seeds in still another way. The seeds of many plants attach themselves to animals, especially quadrupeds, by means of hooks, crotchets, or hairs, which are either affixed

* By my very respectable friend, the late Dr. Jeremy Belknap, of Boston.

to the seeds themselves; as in Hounds-tongue (Cynoglossum), Mouse-ear (Myosotis), Vervain, Water-Hemp-Agrimony (Bidens), and many others; to their calyx, as in Burdock (Arctium Lappa), Agrimony, Rhexia, Dock (Rumex), Nettle, Pelletory (Parietaria), Linnæa, &c. &c.; or to the pericarp, or seed-vessel, as in Liquorice (Glycyrrhiza), Enchanter's Nightshade (Circæa), Cleavers (Galium Aparine), Triumfetta Bartramia, Martynia, Pea-Vines (Hedysara, of various species), not to mention many others.—In this manner, there can be no doubt, that many seeds are very extensively diffused over vast tracts of country. Thus, there are good reasons to believe, that neither Common Hounds-tongue (Cynoglossum officinale), nor Burdock, are natives of the United-States: but both of these plants, which appear to have spread in the manner I have mentioned, are now to be seen in many of the most remote parts of the Union.

The very incorruptible nature of the seeds of plants, is a circumstance highly favourable to their migration*. We have seen, that the seeds of Misletoe, Loranthus, Poke, and others, vegetate very well, after they have been subjected to the digestive power of birds. Nay, it is a fact, that some seeds, when carried to a distance from their native countries, have generally refused to vegetate, until they have been passed through the alimentary canal of birds. In Britain, this was found to be the case with the seeds of the Common Magnolia, or Beaver-tree (Magnolia glauca). This fact will excite less surprize, when it is recollected, how extremely te-

* J. J. Plenck. Physiologia et Pathologia Plantarum, p. 92. Viennae: 1794. 8vo.

nacious seeds are of the vital principle; or, in other words, how difficult it is to prevent seeds from living. Thus, the late illustrious Spallanzani discovered, that there are certain kinds of seeds, which do not refuse to vegetate, even after having undergone the operation of boiling in water; and Duhamel mentions an instance of seeds germinating after they had experienced, in a stove, a heat of 235 degrees by the scale of Farenheit. Spallanzani even found, that the seed of mould, which is a true vegetable, survive a heat infinitely greater than this. We are, morever, well assured, that the seeds of certain species of plants, after having been preserved in the cabinets of the curious, for whole centuries, have vegetated very readily, when committed to the earth, or when simply irrigated with water.

4. MANY seeds are dispersed to a considerable distance by means of an elastic force, which resides in some part of the fructification. In the Oat, and in the greater number of the Ferns, this elasticity is resident in the calyx. In Centaurea Crupina, it resides in the pappus, or aigrette; whilst, in many others, such as Geranium, Herb-Bennet (Geum urbanum), Fraxinella (Dictamnus albus), Touch-me-not (Impatiens), Cucumber (Cucumis), Wild-Cucumber (Momordica), Horse-tail (Equisetum), and many others, it resides in the capsule. The pericarp of Impatiens consists of one cell with five divisions, each of which, when the seed are ripe, upon being touched, suddenly folds itself into a spiral form, leaps from the stem, and scatters, by virtue of this elastic property, its seed to a great distance.

Dr. Darwin has mentioned this phenomenon, in his learned and charming poem, *The Loves of the Plants:*

" With fierce distracted eye Impatiens stands,
" Swells her pale cheeks, and brandishes her hands,
" With rage and hate the astonish'd groves alarms,
" And hurls her infants from her frantic arms".

CANTO III. l. 131-134.

THE pericarp of the Geranium, and the beard of the Wild-Oat (Avena fatua), are twisted, doubtless, for a similar purpose, and, being extremely sensible to the changes of the atmosphere, readily dislodge their seeds on wet days, when the earth is best fitted to receive them. Advantage has been taken of this property of the pericarp of the Geranium, of which an ingenious and neat hygrometer has been constructed *. The Wild-Oat, called " Walking-Oat", is now familiarly known to every body. The awn (arista) of the Barley is furnished with stiff points, which are all turned towards the point of it, like the teeth of a saw. As this long awn lies upon the ground, it extends itself, during the prevalence of the moist night-air, and pushes forwards the grain of Barley which it adheres to. In the day-time, it shortens as it dries, " and as these " points prevent it from receding, it draws up its pointed " end; and thus, creeping like a worm, will travel many feet from the parent stem †". Surely, these facts may, with some propriety, be mentioned as instances of the migration of the seeds of plants.

* See Dr. Withering's Botanical Arrangement, &c. Vol. III. p.597 & 598.
† Darwin.

I proceed, in the next place, to treat

B. II. Of the Germination of the Seed.

The seed, after having been impregnated by the animating pollen, or fecundating powder, of the anthers*, is, at no great distance of time, in a fit state to germinate. Some seeds, indeed, begin to vegetate long before they are detached from the pericarp, or vegetable womb, in which they have received their existence, and passed through some of the tranquil stages of their life. This is the case with the Tangekolli and Agave, formerly mentioned†. Mr. Baker assures us that upon dissecting a seed of Trembling-grass (Briza) he plainly discovered, by the assistance of the microscope, a perfect plant furnished with roots, sending forth two branches, from each of which there proceeded several leaves, or blades, of grass‡. In the Persimmon, the germination of the seed commences long before the fall of the fruit, and even before the fleshy part of it is quite matured: for in the unripe fruit we plainly discern, even with the naked eye, the two beautiful leaves of the embryo, that are afterwards to form the upper part of the tree§. "So in the animal kingdom (as Dr. Darwin observes), "the young of some birds are much more "mature at their birth than those of others. The "chickens of pheasants, quails, and partridges, can use

* See pages 165, 166, &c.; and Part II. † See page 94.

‡ In the seeds of the Nymphæa Nelumbo, and in those of the Tulip-tree, the embryo-leaflets are so similar to those of the adult vegetables, that Linnæus, merely from an examination of these leaflets, was enabled to discover to what vegetables the seeds belonged. See Amoenitates Academicæ, &c. Vol. VI. Dissertatio cxx.

§ See Plate v.

" their eyes, run after their mothers, and peck their " food, almost as soon as they leave the shell ; but those " of the linnet, thrush, and blackbird, continue many " days totally blind, and can only open their callow " mouths for the offered morsel*".

In the greater number of vegetables, however, there is no germination of the seed, exterior to its shell, until after the opening of the pericarp, and the fall of the seed. The germination is then accomplished by different circumstances, which are more or less necessary to this great function of vegetable life. These circumstances are Earth, Air, Water, and Heat. Of each of these, and of some other supposed agents in the business of germination, I shall speak, in a very brief manner, in the order in which I have mentioned them.

1. Although earth is not essentially necessary to the germination of the seed, it is extremely useful, affording a proper situation, a maternal bosom, for this vegetable egg, where it can repose, fix itself, and receive the influence of the various agents, which are more indispensibly necessary to the evolution of its parts. I do not deny, that earths of certain kinds, may be actually absorbed by, and serve as aliment to, the growing seeds of vegetables. I even think it probable that this is the case. But this is one of those points, in vegetable physiology, which has not yet been satisfactorily decided by experiments.

Innumerable facts, however, might be adduced to show, that earth is not absolutely necessary to the

* Phytologia, &c. Sect. ix.

germination of seeds. We have seen, that the seeds of various parasitic plants vegetate very well in the chinks of the bark of other vegetables. Some seeds vegetate upon the most barren rocks, where they can hardly be said to have a particle of earth. But, what is more to our purpose, the seeds of many plants vegetate in the water, and continue, during the whole course of their lives, very completely detached from the earth*. Moreover, seeds of various kinds germinate very readily and rapidly, upon cotton, wool, feathers, sponges, cut paper, and other similar matters, provided they be kept constantly moistened, with water, and exposed to the proper quantity and species of air.

Seeds never vegetate in a very dry earth. The greater number of them will vegetate in any kind of earth, provided it be moist. Even in moist earth, when they are buried at a great distance below the surface, they remain in a profound sleep, and make no visible effort to vegetate, until they are brought much nearer to the surface. They are always later in coming up, in proportion as they are planted deep in the ground. Bierkander, a Swedish writer, has instituted some curious experiments relative to the germination of seeds, of various kinds, at different depths under ground. He found, that the seeds of Flax would never germinate when they had been buried lower than a certain depth, in the earth. He, also, found, that the seeds of this plant would not vegetate in sand.

* See page 19. See, also, Part III. Class xxiv. Cryptogamia.

2. The vast influence of air upon the vegetation of the seed might be shown by many facts. Seeds do not vegetate in *vacuo*, or, if they do vegetate, their growth is precarious and feeble. The celebrated chemist William Homberg, towards the close of the xviith century, made a number of experiments with different seeds placed under the receiver of the air-pump. He observed, that the seeds of Lettuce, Purslane, and Cresses, do sometimes come up in vacuo, but that the number of them is small, and that the leaflets that made their appearance, perished soon after. Boyle, Musschenbroek, and Boerhaave concluded, from their experiments, that the access of air is indispensibly necessary to the germination of the seed. Pease, however, are said to grow in vacuo.

It is, no doubt, owing to the want of air, that seeds which are planted very deeply in the ground, refuse to germinate. But they vegetate very readily when the ground has been ploughed or turned up, and the seeds, in this way, are more immediately exposed to the contact of the atmosphere. The seeds of Black-Oats, after having lain deeply buried in the soil of Scotland, for half a century, have grown vigorously as soon as they were raised near enough to the surface to receive the influence of the air. It is well known, that many seeds do not readily germinate, if soon after they have been planted, rains have fallen. In this case, a kind of crust is frequently formed upon the earth, which prevents the access of air.

Different seeds seem to require very different quantities of air, in order to further their germination.

On this subject, indeed, our knowledge is not very precise. The acorns of some species of North-American Oaks vegetate much quicker when merely laid upon the surface of the earth than when buried at some depth below. The seeds of the Long-leaved Pine (Pinus palustris) vegetate very readily upon the surface of the naked sand, without the least covering of earth; and the nuts of different American species of Æsculus, or Horse-Chesnut, such as the Buck-eye (Æsculus flava), grow as well, if not better, upon, than beneath, the surface of their most proper soils.

In order that seeds may readily germinate, it is not only necessary, that they be exposed to the influence of the air, but that the air be pure, or, at least, as pure as that of the atmosphere. The experiments of Mr. Achard and many other philosophers have plainly proved, that these vegetable ova will not germinate in azotic gas (or phlogisticated air), in carbonic acid-gas (fixed air), nor in hydrogen gas (inflammable air). The Abbe Spallanzani, however, has shown, that the seeds of various species of plants do vegetate very well in confined or stagnant air, provided there be a plenty of this air*. The same remark applies to the eggs of many species of insects, and other animals, notwithstanding the assertions of the great Boerhaave, and other writers, to the contrary.

Unquestionably, however, pure air is peculiarly favourable to the germination of the seed. Thus,

* Experiments and Observations upon animals and vegetables confined in stagnant air. English Translation.

Huber, who has devoted much attention to this interesting subject, has shown, that seeds which had refused to vegetate in azotic gas, did vegetate when to this gas he added a small portion of oxygen gas*. He has likewise shown, that the first developement of seeds is more rapid in this gas than in the common air. It would, indeed, seem that it is oxygen gas alone that gives to seeds their first determination to germinate; just as the same gas seems to be the first exciting cause of the movements of the irritable fibre of the embryo-chick, *in ovo*†. It is not improbable, that many of the seeds of the plains and vallies, when carried to the summits of high mountains, refuse to vegetate there, in some measure, from the circumstance of their having in the elevated regions of the atmosphere, a smaller quantity of oxygen gas than in the climate below.

The very ingenious F. A. Humboldt has shown, that Pease and French Beans that had been sowed in sand, and watered with water to which was added oxygenated muriatic acid, grew much more quickly than those which were irrigated with water alone. The same seeds perished when they were watered with water to which was added the simple muriatic acid: which plainly proved, that it was the oxygen of the acid, and not the acid itself, which had so greatly disposed the seeds to germinate. When the seeds of the Garden-cress (Lepidium sativum) were watered with the diluted oxygenated muriatic acid, they exhibited their leaflets

* According to the modern chemists, the atmosphere of our globe is composed of azotic gas and oxygen gas, in the proportion of about seventy-three parts of the former and twenty-seven parts of the latter. The carbonic acid gas (or fixed air), is deemed an accidental part of the atmosphere.

† See page 53.

at the end of six hours: but the same seeds were only thus far advanced in germination, at the expiration of thirty-six hours, when they had been watered with common water. At Vienna, where Professor Jacquin and others have paid much attention to this curious and really important subject, it was found, that certain old seeds, which had always refused to vegetate, were brought to vegetate by irrigating the earth in which they were planted, with water, to which was added the oxygenated muriatic acid. This was found to be particularly the case with the seeds of Dodonæa angustifolia, and Mimosa scandens.

Mr. Humboldt has, also, shown, that seeds which were planted in the calces of metals (which are all compound bodies consisting of the reguline matter, or metal, and oxygen), such as the oxydes of lead, called red-lead, and lytharge, if they be irrigated with water, will more readily vegetate than when committed to the earth; and that they will not vegetate when planted in the powder of the same metals, not in the state of oxydes.

These various facts, the discovery of which may be said to constitute an important era in the science of Vegetable Physiology, prove, in the most satisfactory manner, that oxygen gas, or vital air, is absolutely necessary to the complete developement of the embryo of the seed. It is proper, however, to observe, that the purest oxygen gas, and even common air entirely freed from its carbonic acid, are less proper for the germination of the seed, than oxygen gas to which is added a portion of azotic gas; or than the atmospheric

air in union with a pittance of carbonic acid gas. It, moreover, appears, that common atmospheric air is better adapted to the germination of the seed, but particularly to the progress of the plant, after it has acquired more size and strength, than is oxygen gas. These facts are calculated to show the great affinity of animal and vegetable life: nor are they without their value in a practical point of view.

It is highly probable, that the seed, as well as the more adult plant, is capable of decomposing the carbonic acid, that may be offered to it, detaching the oxygen of this acid from its radical or base, which is carbon*.

As air is so indispensible an agent in forwarding the germination of the seed, it must be obvious, that where we wish to prevent seeds from vegetating, we should carefully seclude them from the air, especially a warm and moist air†, by covering them, and keeping them in a cold and dry place. In this manner, they

* Chaptal and some other chemists have asserted, that plants live in azotic gas, "and freely vegetate in it". My colleague Dr. James Woodhouse informs me, that, in a *solitary* instance, a *single* seed of Water-Melon had germinated very well in this gas. We are certain, however, that *almost* universally the gas in question is highly unfavourable to the germination of the seed, and to its future progressive growth.

† Some seeds, we are told, keep best when they are exposed to the air, whilst others have their determination to germinate preserved by a total exclusion from the air. Mr. Miller informs us, that the seeds of Parsley, Onion, Lettuce, and other vegetables, that were kept in vials hermetically sealed, for a whole year, did not germinate, while those of the same age, hung up, in bags, in a dry room, vegetated freely. For much valuable information concerning the best method of preserving seeds, I must refer the reader to Mr. Ellis's *Directions for bringing over Plants and Seeds*, &c. See, also, Mr. Curtis's *Companion to the Botanical Magazine*, &c. pages 27-33.

may be preserved for ages. There can be no doubt, moreover, that the seed will be preserved for a much longer time in an air less pure than in one more pure. Accordingly, it is the practice of many who keep seeds for curiosity, to put them in glass vessels, with a little sulphur, or camphor, and well corked. From what will presently be observed, it would appear probable, that the preservation of seed will be still further effected by keeping them more in the light, than in dark situations.

3. WATER is another of the indispensible agents in forwarding the vegetation of the seed. No seeds will germinate if they be placed in a situation where the air is perfectly dry. Hence seeds which are kept perfectly dry in the cabinets of the curious, and in similar situations, never vegetate, but the same seeds begin to sprout in a very short time, when they are irrigated with water. The seeds of aquatic plants will not vegetate unless in water, or in a very moist soil. But the seeds of many of the land-plants perish if they be kept too moist. Each seems to require a certain determinate quantity of water to further its germination. In general, those seeds which have a loose testa, or shell, require more water for their germination than those whose shell is more close.

4. A CERTAIN degree of heat is indispensibly necessary to the germination of the seed. During the severe weather of the winter-season, the seeds which have been placed in the earth do not germinate, but remain inactive in a state perhaps very similar to the torpid condition of many animals; but on the coming on

of spring, the "penetrative sun"* rouses the embryo, from its slumber, into active life.

It is unnecessary to dwell upon this subject, for the agency of heat, in the business of germination, is familiar to every one. I shall only add, that from the influence of heat upon the seed, we learn, that the period of its germination is not a determinate law, in respect to time. The same seed which, in an ordinary degree of heat, requires six hours to germinate, may be brought to this state, in three hours, by exposing it to a greater degree of heat. In this respect, as well as many others, there is a great affinity between the seeds of plants, and the eggs of birds. This observation may, I believe, be extended to the eggs of some of the amphibious animals, such as the serpents.

5. Although the influence of light upon plants that have made their appearance above the earth is extremely great, and indipensibly necessary to the healthy state of the vegetable†; it is certain, from actual experiments, that light is not necessary to the first germination of the seed. Mr. Fourcroy and other writers have, indeed, asserted, that light is necessary to this function of the vegetable egg. But the contrary has been shown by numerous experiments, as those of Curtis, Ingen-housz, and other writers. Nay, it has been ascertained, that seeds, which have never felt the influence of the solar light vegetate more quickly than those which have received its influence. Many plants, originating from seeds, grow and come to perfection in the darkest mines, and in other similar situations.

* Thomson. † See Part II.

Dr. Ingen-Housz and Mr. Senebier have both shown, that seeds which were planted in the dark vegetated sooner than those which were planted in the light. The Abbe Bertholon has opposed this idea. This respectable writer supposed, that the seeds would actually vegetate quicker in the light than in darkness, provided they could, in both instances, be exposed to the same quantity of water. To determine this point with certainty, Mr. Senebier made the following experiment. He placed Peas, Beans, and French-Beans (Haricots), upon sponges which were equally wetted, and enclosed them in vessels of a given size. He exposed some of them to the light of the sun, and by them others in cases of tin plates, painted of a deep red colour. They were all exposed to the same degree of heat. The water which might evaporate from the sponges was prevented from escaping, so that, upon this ground, there could be no source of deception. The germination proceeded much more rapidly in the darkened cases than in those which were exposed to the influence of the light.

The very different effects of light upon the seed and upon the more evolved and adult vegetable, is one of the various circumstances which seem to render it highly probable, that light and heat are fluids essentially distinct from each other*, however frequently they may be combined together.

6. Electricity deserves to be mentioned, in this place. It must be remarked, however, that authors are much divided in opinion concerning the real effects of

* See the fine experiments of Dr. Herschel, and other writers. See, also, Darwin's Phytologia, &c. Sect. xiii.

this fluid upon the germination of the seed. Dr. Darwin observes, that "the influence of positive or vitreous "electricity in forwarding the germination of plants and "their growth seems to be pretty well established *". Mr. D'Ormey is said to have found various seeds to vegetate sooner and to grow taller when they were put upon his insulated table, and supplied with electricity. Mr. Bilsborrow's experiments, which are recorded by Dr. Darwin, seem to prove, that Mustard-seed which were subjected to positive or vitreous electricity, and to negative or resinous electricity, vegetated much sooner than seeds which were not electrised, "but otherwise "exposed to the same circumstances". The Abbe Bertholon, whom I have already mentioned, is of opinion, that both natural and artificial electricity encrease the germination of the seed, and the future growth of the plant. Dr. Ingen-housz, from his experiments, was obliged to deduce a very opposite conclusion; and Mr. Senebier, in a very late publication, concludes, that the influence of the electrical fluid is, "at least, doubtful†".

7. THERE are, doubtless, many other agents which exert an effect more or less decided on the germination of the seed. It is probable, that most of the various manures which increase the living powers of the more adult plant, exert a similar effect up the embryo within its shell. But the very different effects of light upon the seed and upon the evolved plant, should teach us the propriety of treating this subject with caution. Mean-

* Phytologia, &c. Sect. XIII.

† "Je ne dirai rien de l' Electricite puisque son influence est au moins douteuse". Physiologie Vegetale, &c. Tom. 3. p. 399.

while, I think it may be confidently asserted, that various stimulants, such as nitre (nitrate of potash), common salt (muriate of soda), green-vitriol (sulphate of iron), blue-vitriol (sulphate of copper), gypsum or plaster of Paris (sulphate of lime), charcoal, and many others, if they be applied in their proper dose, exert a considerable effect in hastening the germination of the seed.

* * * * * * * *
* * * *

The time at which different species of seeds, after having been committed to the earth, begin to vegetate, is exceedingly various. Thus, Millet (Milium), and Wheat, vegetate in one day; Kidney-Bean, Mustard, and Spinach (Spinacia), in three days; Lettuce and Fennel (Anethum Fœniculum), in four days; Cucumber, Gourd, and others, in five days; Beet and Radish, in six days; Barley in seven days; Orache (Atriplex), in eight days; Cabbage, in ten days; Beans (Faba), from fifteen to twenty days; Onion, from nineteen to twenty days; and Parsley (Apium Petroselinum), from forty to fifty days.—Of the common garden-seeds, I believe there are none which take a shorter time to vegetate than several of the Tetradynamous plants, such as Mustard, and Turnip; nor any, I think, a longer time than Parsley. The long torpidity of the last-mentioned seed has given rise to a vulgar proverb, in Britain, "that Parsley-seed goes nine times "to the Devil, before it comes up".

The seeds of many vegetables take a whole year to vegetate. Such are the Peach, the Almond, the Walnut, the Chesnut, the Peony (Pæonia officinalis), different species of Canna, or Indian-Reed, and others. Other seeds require two years before they vegetate: such are the Common Dogwood (Cornus florida), and other species of the genus: the Common Pappaw, or Custard-apple (Annona triloba), and the Filbert (Corylus avellana). Some seeds, even under circumstances favourable to their growth, remain a much longer time in the earth before they vegetate. But, with respect to these seeds, the period of their germination may be greatly advanced by different means, which are familiar to the gardeners. Thus, several of the hard-shelled seeds, particularly the nuts, which require one or more years to vegetate, can be brought to vegetate much earlier, simply by rendering their shells thinner, by a file, or other similar means. The seeds of the Pappaw, which I have already mentioned, may, in this manner, be brought to germinate in a few days. Some writers, however, are of opinion, that this method of treating the harder putamens is not adviseable. Mr. Miller advises us to put such seeds between two tiles, with a sufficient quantity of earth, and to place them in a fresh hot-bed, that they may open spontaneously.

It is uncertain how long seeds may exist without loosing their vegetative property. There are good reasons, however, to believe, that the life of certain kinds of seeds may be protracted far beyond that of any other part of the vegetable, or than the life of any species of animal. It is true, indeed, that the Mosses which have been kept for near two hundred years, in *herbaria* of

the botanists, have seemed to revive by the simple process of irrigating them with water*. Perhaps, the Wheel-animal (Rotifer), which, in this respect, is nearly allied to the Mosses and to seeds, might be preserved for as great a length of time in the sand of tiles and sewers†, where it is not permitted to receive the influence of moisture. But, with respect to seeds, it is certain, that when excluded from the influence of the air, and kept from moisture, they may exist for centuries. The phenomenon, so familiar to Americans, of the successive appearance and growth of different species of timber in the same tract of country, is greatly in favour of this idea. I have little hesitation in supposing, that different kinds of seeds, if imbedded in stone or dry earth, and removed far from the influence of air and moisture, might be made to retain their vegetative quality for a thousand years. But, after all, it is not certain, that this singular immortality, *upon earth*, is the exclusive privilege of the seed. "LIFE IS A PROPERTY WE DO NOT UNDERSTAND‡". AND WE NEVER SHALL UNDERSTAND IT, IF WE ATTEMPT TO CONSTRUCT SYSTEMS, BEFORE WE KNOW HOW OR WHERE TO COLLECT FACTS. "Life, however feeble and obscure, is always life; between it and death, there is a distance as great as between entity and non-entity §".

* Speaking of the Mosses, Dr. Haller has the following words: "Immortalitatis pene æmulo privilegio hæc eadem folia gaudent; quæ post centenos, & ducentos forte annos, sola in aqua maceratione, in pristinum vigorem restituti possint, quod experimentum in nonnullis C. Bauhini Muscis feci". Alberti v. Haller Historia Stirpium Indigenarum Helvetiæ Inchoata. Tom. III. p. 18. Bernæ: 1768.

† See the wonderful observations of Lewenhoek, Baker, Roffredi, Spallanzani, Fontana, &c. &c.

‡ John Hunter. § Spallanzani.

I SHALL terminate these observations on the seed by observing, that in the germination of this egg, the plumule constantly mounts upwards to meet the air, whilst the radicle shoots downward, to its mother earth. The mechanical philosophers have attempted an explanation of this singular phenomenon. But their ingenuity, as might be expected, has been fruitlessly employed. I am not certain, that Dr. Darwin has thrown much light upon the subject. He observes, that "the "plumula is stimulated by the air into action, and "elongates itself, where it is thus most excited; and "the radicle is stimulated by moisture, and elongates "itself thus, where it is most excited, whence one of "them grows upwards in quest of its adapted object, "and the other downward *". But I do not think there is much difference between this species of language, and that of those writers who have ascribed the ascent of the plumule and the descent of the radicle to "a mysterious instinct", or to "a sort of affectation". The time may possibly arrive, when these movements of the embryo in its germinating state, will be deemed instances of "determinate instinct", as much as the first movements of certain species of birds, when they have escaped from their egg; as much so as the instinct which impels the duckling to seek the water, or the chick of the American Pheasant (Tetrao Cupido), to seek the wood, though neither of them have been hatched under females of their own kind†.

* Phytologia, &c. Sect. IX.

† Mr. Dodart planted, in a pot, six acorns, with the points of their embryos upwards, in as perpendicular a direction as he could. At the end of two months, upon removing the earth, he found that all the radicles had made an angle to reach downward, "as if (to use the words of Father Regnault) "they had been sensible of the botanist's fraud".

§. VIII.

THE Receptaculum*, or Receptacle, is the seventh and last part of the fructification enumerated by Linnæus. He defines it, "the base by which the other parts of the "fructification are connected". "Basis qua partes "fructificationis connectuntur†". To this part of the fructification Dr. Boerhaave gave the name of *Placenta*, and the ingenious Sebastian Vaillant that of *Thalamus*.

THE following species of receptacle are enumerated by Linnæus: viz. 1. Receptaculum *Proprium*. 2. *R. commune*. 3. *Umbella*. 4. *Cyma*: and, 5. *Spadix*. In this place, I am to speak of only the two-first mentioned receptacles. Of the three last, I shall treat under a separate head, viz. that of inflorescence, or the mode of flowering.

A. THE *receptaculum proprium*, proper or peculiar receptacle, appertains to one fructification only. Of this kind is the receptacle of all the simple flowers. This species of receptacle has received different names from the particular parts of the fructification which it supports and connects. Thus,

1. THE *receptaculum fructificationis*, or receptacle of the fructification, is common both to the flower and the fruit; or, in other words, embraces the corolla and the germ.

2. THE *receptaculum floris*, or receptacle of the flower. Here, the receptacle supports the parts of the

* Receptaculum, from *Recipio*, to receive.

† Philosophia Botanica, &c. p. 54. §. 86.

flower only. In these cases, the germen, or seed-bud, which is placed below the receptacle of the flower, has a proper base of its own. The last mentioned species of receptacle is denominated

3. *Receptaculum fructus*, or receptacle of the fruit. We have examples of it in Gaura, Oenothera, and others*.

4. *Receptaculum seminum*, or receptacle of the seed. This is the base to which the seeds are fastened, within their enclosure, or pericarp. This species of receptacle is denominated, by some botanists, *placenta*, because it is the common receptacle of the *vasa umbilicalia*, or umbilical vessels, through which nourishment is conveyed to the seeds. It has no definite form, except when the common receptacle is absent. It arises often from the receptacle of the fruit, or from the mother-pericarp itself.—This species of receptacle assumes a variety of forms, of which it is not my intention to take notice, in this place. I shall content myself with observing, that when it is of a filiform or thread shape, it is called *funiculus umbilicalis*, or the navel-cord. The form of this cord is very frequently that of a slender thread. In the Leguminous plants, however, it resembles a fungous peduncle†. In Date (Phœnix), and Lontarus, it better deserves the name of a cord, being composed of several fibres, and thicker than a quill. The cord is often simple: but in a few vegetables, it is divided into two branches (rarely into more) at the extremity, nearest to the seed. Of these branches, some-

* See Plate xvi.

† See Plate xxi.

times only one bears a seed, and the other serves the purpose of a fulcre, as in some species of Vicia and Lathyrus. Sometimes, both of the branches have a proper seed affixed to them, as in Tulip-tree. In Magnolia (and some other plants), two seeds hang from one individual cord, of a cotton-like substance.

By means of the cord, the seed coheres intimately with its pericarp, until the nutritious vessels being closed at maturity, the cord is broken, and the seeds being thus set at liberty, are scattered upon the earth, or other places, from which they draw their future nourishment, in the manner we have seen*.

B. The *receptaculum commune*, or common receptacle, connects several florets or distinct fructifications, so that if any one of them be removed, an irregularity is occasioned. We have instances of this species of receptacle in the Compound-flowers, and also in the Umbel, Cyme, Spadix, and Rachis, which are afterwards to be mentioned †.

The receptacle is, 1. *punctatum*, dotted or punctate; sprinkled with hollow points, or dots: as in Leontodon, Cacalia, Ethulia, Chrysanthemum, and others. 2. *pilosum*, hairy; having hairs between the florets, as in Carduus, &c. 3. *paleaceum*, paleaceous or chaffy; the florets being separated by intermediate scales, resembling chaff; as in Teasel (Dipsacus), Scabious (Scabiosa), &c. 4. *nudum*, naked; neither dotted, hairy, nor paleaceous; as in Leontodon, Lactuca, Sonchus, &c. &c. 5. *planum*, flat. 6. *convex-*

* See pages 266, &c. † See Plates XXIII & XXIV.

um, convex. 7. *conicum*, conical, columnar; attenuated towards the apex. 8. *subulatum*, subulate. 9. *alveolatum*, alveolate, or honey-combed; divided into open cells, like an honey-comb, with a seed lodged in each cell; as in Cotton-Thistle (Onopordum), and others.

In drawing the generic characters of plants, the receptacle is a part which ought always to be attended to. It is seldom omitted by Linnæus, in his *Genera Plantarum*. In discriminating the genera of the class Syngenesia, it is a character of very great importance.

I have now finished the consideration of all the seven parts of the fructification enumerated by Linnæus. I shall conclude the first part of these *Elements* with some account of the *Inflorescentia*, or Inflorescence of vegetables, and the *Calendarium Floræ*.

§. IX.

By the term Inflorescentia, Linnæus means the various modes in which flowers are fastened to the plant, by means of the peduncle*. This is what Ludwig, and many other botanists have denominated *Modus Florendi*. These modes are thirteen in number, viz. 1. *Spadix*. 2. *Cyma*. 3. *Umbella*. 4. *Spica*. 5. *Amentum*. 6. *Strobilus*. 7. *Corymbus*. 8. *Racemus*. 9. *Panicula*. 10. *Thyrsus*. 11. *Fasciculus*. 12. *Capitulum*: and, 13. *Verticillus*. The three first of these

* "Inflorescentia est modus quo flores pedunculo plantæ annectuntur, "quem *Modum* Florendi dixere antecessores". Philosophia Botanica, &c. p. 112. §. 163.

have already been mentioned under the head of receptacle, but are to be more particularly noticed in this place.

1. The Spadix is the receptacle of the Palms and some other plants, and proceeds from that species of calyx which is called spatha, or spathe*. It is either branched (*ramosus*), as in the Palms; or simple (*simplex*), as in Indian-Turnip (Arum triphyllum), Polecat-weed, or Skunk-Cabbage (Dracontium foetidum), and others.

The simple or unbranched spadix admits of some variety. Thus, in Calla, Dracontium, Pothos, and Golden-club (Orontium aquaticum), the florets cover it on all sides. In Indian-Turnip, they are disposed on the lower parts only, and in Grass-wrack (Zostera marina), on one side only.

According to the number of flowers which it supports, the spadix has received the following names, viz. 1. *uniflorus*, one-flowered. 2. *biflorus*, two-flowered. 3. *multiflorus*, many-flowered.

2. The Cyma†, or Cyme. This is defined by Linnæus to be an aggregate flower composed of several florets sitting on a receptacle, producing all the primary peduncles from the same point, but having the partial peduncles scattered or irregular; all fastigiate, or forming a flat surface at top. We have instances of the cyme in Guelder-Rose or Snow-Ball (Viburnum Opulus), in

* See pages 117 & 118.

† Cyma signifies properly a sprout or tender shoot, particularly of the Cabbage. In these senses, the term is used by Pliny, and Columella.

Ophiorhiza, and various species of Cornel or Dogwood, such as Cornus sanguinea, Cornus sericea, &c. &c.

The cyma is either, 1. *bracteata*, bracteate; furnished with bractes: or, 2. *nuda*, naked; without bractes.

Flowers which are disposed in a cyme, are called cymose flowers; *cymosus flos*. In the former editions of Linnæus's *Fragments of a Natural Method*, place was given to an order, *Cymosæ*, consisting of Honeysuckle, Morinda, Loranthus, and a few other genera. In later editions of the work, most of these genera were removed to the order *Aggregatae* *.

3. The Umbella, or Umbel, is a receptacle stretched out into filiform proportioned peduncles from the same centre. I have already given some account of this species of receptacle, or mode of flowering, when treating of the involucrum, or involucre†. Several circumstances, however, respecting the umbel are to be noticed in this place.

a. The umbel is either, 1. *simplex*, simple, or undivided; as in Ginseng (Panax quinquefolium). 2. *composita*, compound; each peduncle bearing another little umbel, or umbellule. In this case, the first or larger set of rays, constitute the universal umbel *(umbella universalis)*; while the second or su-

* See Part III.

† See pages 113 & 114. See, also, Part III. Class v. Pentandria.

bordinate set of peduncles constitute the partial umbel *(umbella partialis)*. 3. *prolifera*, proliferous, superdecompound, or more than decompound.

b. The umbella is also, 1. *concava*, concave. 2. *fastigiata*, fastigiate; or rising gradually like the roof of a house. 3. *convexa*, convex. 4. *erecta*, erect. 5. *nutans*, nodding. 6. *terminalis*, terminal. 7. *axillaris*, axillary; and, 8. *oppositifolia*, oppositifolious.

Flowers which grow in the manner of an umbel, are denominated *Umbellati*, Umbellate, or Umbelled flowers. By many writers, they are denominated Umbelliferæ, or Umbelliferous plants.

Umbellatæ is the name of the twenty-second order in Linnæus's Fragments; and of the forty-fifth in his natural orders. The greater number of these plants belong to the second order of the fifth class of the sexual system. Ray, Jussieu, and other writers, have called these plants, Umbelliferæ, and Cæsalpinus, *Ferulaceæ*. I shall, in a more proper place, give a list of the principal genera of this great natural family *.

4. The Spica†, or Spike, is a species of inflorescence in which sessile flowers, or flowers without peduncles, are (scatteringly) alternate on a common simple peduncle. We have examples of this mode of inflorescence in an ear of Wheat, Rye, or Barley, and many other

* See Part III. Class v. Pentandria.

† From *spes*, hope: from σπιζω, to extend; or from σπαχυς Æol. for σταχυς, whence *Spicus*, *Spica*, and *Spicum*, "for (as Dr. Martyn observes) it is used in "all the three genders". These terms signify an ear of corn.

Grasses; and in Lavender (Lavendula), Mullein (Verbascum), Agrimony, and many other plants.

The flowers of a spike are situated immediately upon the stalk, without any partial peduncles, or footstalks, as has already been observed. This circumstance distinguishes the mode of inflorescence of which I am speaking, from the raceme, which is presently to be mentioned. Often, however, in a spike, along with the sessile flowers, we find flowers that are pedunculated; as in some species of Cyperus, &c.

The spica is, 1. *secunda* *, single-rowed or one-ranked †; that is all turned towards one side, or directed or inclined the same way. We have an instance of this in American Cock's foot-grass (Dactylis cynosurioides). 2. *disticha*, two-ranked or rowed; all the flowers pointing two ways; and, consequently, opposed to secunda. This is instanced in Bog-Rush (Schoenus), &c. 3. *tetrasticha*, four-ranked. 4. *hexasticha*, six-ranked.

The *Spicula*, Spicule, or Spikelet, is a partial spike, or a subdivision of a true spike. This occurs in some of the Grasses, as Darnel, &c.

The filiform receptacle which connects the florets longitudinally into a spike, is denominated *Rachis* ‡. "Receptaculum filiforme flosculos longitudinaliter annectens in spicam §". It has received the name of

* "We have no proper English term for this. *One-ranked* tends to mislead, because a plant may have more ranks or rows of flowers than one directed to the same point of the horizon, or nearly so". Professor Martyn.

† Darwin.

‡ Ῥαχις, the back-bone, or spine. § Delineatio Plantæ.

rachis, from its bearing some resemblance, when it is naked or deprived of the florets, to the spine. We have good examples of this species of receptacle in different species of Panic-grass, such as Panicum crus corvi, P. crus galli; in Darnel (Lolium), and in many other Grasses.

5. Of the Ament and Strobilus, I have already taken particular notice, when treating of the various species of calyx *, and of pericarp †. I shall only observe, in his place, that the ament is more properly referred to the head of inflorescence than that of calyx ‡.

6. The Corymbus, or Corymb §, is said by Linnæus, to be "made up of a spike, whilst each flower "is furnished with its proper footstalk, or peduncle, in "an elevated proportioned situation". Linnæus's definition is not very intelligible, and hence different botanists have given a different interpretation of the words. In this species of inflorescence, the smaller or partial flower-stalks are produced along the common stalk, on both sides, and although they are of unequal lengths, they rise to the same height, so as to form at the top, a flat and even surface.

We have examples of this mode of flowering in the following, among other, vegetables, viz. Nine-bark or Seven-bark (Spiræa opulifolia, Scurvy-grass (Cochlea-

* See pages 115-117. See, also, Plate XXVII.

† See pages 195 & 196.

‡ The Strobile gives name to a particular species of spike (*spica strobiliformis*), or strobile-shaped spike, of which we have an example in Justicia Ecbolium.

§ Professor Martyn.

ria officinalis), Gold of Pleasure (Myagrum sativum), and other Tetradynamous plants.

The corymb differs from the umbel in this circumstance, that in the former the numerous partial footstalks take their origin from different parts of the common stalk; whilst in the latter, as we have already seen, all the peduncles proceed from a common centre. The corymb, it has been observed, is a mean between the umbel and the raceme. Like them, its flowers are furnished with their proper footstalks, which rise gradually from the bottom to the top, as do those of the raceme, and are extended to the same height, as are those of the umbel.

The term corymbus is sanctioned by classical authority. Pliny uses it for a cluster of Ivy-berries. "Hederæ racemis in orbem circumactis, qui vocantur "corymbi *". Columella puts it for the head of an Artichoke, or Thistle:

"Haec modo purpureo surgit glomerata corymbo †".

7. Racemus‡, Raceme, or Cluster, is the name of the eighth species of inflorescence enumerated by Linnæus. It is a species of flowering in which the flowers, placed along a common footstalk, are furnished with short proper footstalks that proceed as lateral branches from the common stalk.

The raceme and the spike are nearly allied to each other: for in both, the flowers are placed along a com-

* Naturalis Historiæ Lib. xvi. cap. xxxiv.

† De Re Rustica, &c. Lib. x. De cultu Hortorum, l. 237.

‡ From ῥαξ, ῥαγος, *acinus racime*.

mon footstalk, or receptacle; but in the spike, as we have seen, the flowers are sessile, whereas in the raceme they are pedunculated. In general, too, the flowers are less abundant in the spike than in the raceme. But to this, there are many exceptions. I have already noticed the essential difference between the raceme and the corymb.

The racemus is, 1. *simplex*, simple; or, 2. *compositus*, compound. 3. *unilateralis*, one-sided; having all the flowers growing on one side of the peduncle; as in Serrated Winter-green (Pyrola secunda). 4. *secunda*, all bent or directed the same way. 5. *pedatus*, pedate. 6. *conjugatus*, conjugate. 7. *erectus*, erect. 8. *laxus*, loose. 9. *dependens*, hanging down and pointing to the ground. 10. *nudus*, naked. 11. *foliatus*, leafy.

We have good and familiar examples of the raceme in the Vine, the Currant, the Poke, different species of Prunus, or Plumb, such as the common Wild-Cherry (Prunus virginiana), &c.

In the Latin language, racemus signifies a cluster or bunch of Grapes, Ivy-berries, &c. Thus Pliny: Hederæ "est minor acinus, sparsior racemus *".

8. Panicula†, or Panicle, is the name of the eight species of inflorescence. In this, the flowers or fruits are scattered on peduncles, variously subdivided. In other words, it i a kind of branching or diffused spike,

* Lib. xvi. cap. xxxiv.

† From πανικη, *coma*, a bush or head of hair (see page 80), &c.; or rather from *panus*, the woof about the quill in the shuttle. Pliny, in one place (Lib. xvi. cap. xxxvi.) uses this word to designate the down upon Reeds.

composed of a number of small spikes, which are fixed along a common receptacle, or footstalk. We have instances of this form of inflorescence in Oats, Panic-grass, and many other plants.

The following are the principal species or varieties of panicula enumerated by the botanists, viz. 1. *panicula congesta*, a heaped panicle; having a great abundance of flowers. 2. *p. densa*, a dense or close panicle (This is an higher degree of the above; or, in other words, a panicle which has the flowers both close and abundant). 3. *p. spicata*, a spiked panicle; approaching in form to a spike; as in Phleum crinitum, and other Grasses, which are called Spiked Grasses. 4. *p. contracta*, a contracted panicle; a greater degree of the foregoing. 5. *p. coarctata*, a squeezed panicle; having the peduncles extremely near to each other. 6. *p. patens*, a spreading panicle; having the peduncles spreading out so as to form an acute angle with the stem. 7. *p. diffusa*, a diffused panicle; having the peduncles spreading out more and more irregularly. 8. *p. divaricata*, a divaricating panicle; spreading out still more, at an obtuse angle with the stem.

9. The Thyrsus*, or Thyrse, is a mode of inflorescence very nearly allied to the panicle, being, in fact, a panicle contracted into an ovate, or egg-shaped form. In the thyrse, the lower footstalks, which are longer, extend horizontally, whilst the upper ones are shorter, and rise up vertically. We have instances of this beautiful species of inflorescence in Lilac (Syringa vulgaris), in Butter-bur (Tussilago Petasites), and other plants.

* The Greek Θυρσος from θυω, *impetu feror, erumpo*, to burst forth.

10. The Fasciculus *, or Fascicle, is a species of inflorescence, in which several upright, parallel, fastigiate, approximating flowers, are collected together †; as in Sweet-William (Dianthus barbatus), and others.

11. The Capitulum ‡, or Head, isthat species of inflorescence, in which several flowers form a kind of ball, or head, at the extremity or summits of the foot-stalk; as in Globe-amaranthus, or Bachelor's Buttons (Gomphrena globosa), and others.

The capitulum is, 1. *globosum*, globular or round; as in Gomphrena globosa. 2. *dimidiatum*, halved; hemispherical, or resembling half a head; as in Lippia hemisphærica. 3. *ovatum*, ovate; or egg-shaped; as in Lippia ovata. 4. *hispidum*, hispid, or bristly; as in Field-Basil (Clinopodium vulgare). 5. *foliosum*, leafy; intermixed with leaves. 6. *nudum*, naked; having no leaves: of course opposed to the leafy. 7. *pedunculatum*, peduncled, or furnished with little footstalks; as in Teucrium capitatum. 8. *sessile*, sessile; having no short footstalks; as in Teucrium pumilum. 9. *pyramidatum*, pyramidal; shaped like a pyramid; as in Lippia americana. 10. *subrotundum*, subrotund, or roundish; as in Selago fruticosa.

12. The Verticillus § is the thirteenth and last species of inflorescence enumerated by Linnæus. It is

* Diminutive, from *fascis*, a bundle.

† Colligit (says Linnæus) flores erectos, parallelos, fastigiatos, approximatos".

‡ *Capitulum*, in Latin, signifies a little head, the top, or chapeter of a pillar, &c.

§ From *verto*, to turn.

called in English the Whirl or Whorl *. It is made up of many subsessile flowers, which surround the stem, in the form of a ring. We have instances of this inflorescence in Penny-Royal (Mentha Pulegium), Horehound (Marrubium vulgare), Callicarpa americana †, and many other plants. This species of inflorescence, indeed, gives name to an extensive natural family of plants, which are particularly mentioned in the course of this work ‡.

The verticillus is, 1. *sessilis*, sessile, without peduncles. 2. *pedunculatus*, peduncled; with peduncles. 3. *nudus*, naked; without involucre, bracte, or bristle. 4. *bracteatus*, bracted; furnished with bractes. 5. *involucratus*, involucred; furnished with an involucre. 6. *confertus*, crowded. 7. *distans*, distant. 8. *remotus*, remote.

13. I have now given some account of all the various species of inflorescence that are enumerated by Linnæus. But I must not close this subject, without observing, that in some plants the flowers grow upon the leaves. This is the case in the genus Ruscus, or Butcher's broom. Linnæus does not designate this species of inflorescence (for such it seems entitled to be called) by any particular name; but in Ruscus, he calls it "leaf-bearing". A similar mode of flowering occurs in Osyris japonica; a native of Japan. Professor

* It is most commonly written whorl; but whirl seems the more proper orthography; "since (as Martyn observes) it must be derived from the verb *to whirl*, which signifies to turn rapidly".

† See Plate x. Fig. 3.

‡ See Part III. Class XIV. Didynamia.

Thunberg *, who observed it in this vegetable, speaks of it as a very rare species of structure in the vegetable world.

Calendarium Floræ.

" Poma dat Autumnus, formosa est messibus Æstas,
" Ver præbet flores".

Ovid.

The *Calendarium Floræ*, or Calendar of Flora, should contain an exact register of the respective times in which plants of any given province or climate, germinate †, expand ‡, and shed their leaves §, and also flowers, and ripen and disperse their seeds ‖. It should also contain a register of the states or changes of the weather, as they are indicated by the thermometer, the barometer, hygrometer, &c.; with remarks concerning the appearances of electrical or other phenomena; such as lightning, the aurora borealis, earthquakes, lampades, and other atmospheric meteors, &c. To these may be added notices concerning the appearance and disappearance of different species of birds; the seasons of their amours, their incubations, &c.; together with remarks concerning the appearances, the depredations, &c., of insects, and other animals. These last-mentioned circumstances do not, indeed, form a necessary

* Flora Japonica, &c. p. 31.

† See pages 266, &c. &c.

‡ See pages 63 & 64.

§ See pages 64 & 65.

‖ " *Calendaria Floræ* quotannis conficienda sunt in quavis Provincia, secundum Frondescentiam, Efflorescentiam, Fructescentiam, Defoliationem, observato simul Climate; ut inde constet diversitas Regionum inter se". Philosophia Botanica, &c. p. 276. §. 335.

part of a Calendarium Floræ, but they are of service in a variety of ways.

THERE is, undoubtedly, a very remarkable coincidence between the vegetation of some plants and the arrival of certain birds of passage. Linnæus has observed, that the Wood-Anemone (Anemone nemorosa) blows in Sweden on the arrival of the Common Swallow (Hirundo urbica), and that the Marsh-Marygold (Caltha palustris), blows when the Cuckow (Cuculus canorus) sings*. Nearly the same coincidence was remarked in England by Mr. Stillingfleet. Dr. Darwin observes, that the "word Coccux in Greek signifies both a young "fig and a cuckow, which is supposed to have arisen "from the coincidence of their appearance in Greece †". Many instances of a similar coincidence might be pointed out between the flowering of certain North-American vegetables and the arrival of particular species of birds Thus, it is observed, that the Wood-cock (Scolopax Gallinago) commonly visits the neighbourhood of Philadelphia, when the American Elm (Ulmus americana) is in full blossom; that is between the 8th and the 18th of March. Many of our Indians consider the coming of the Goat-sucker, or Whip-poor-will (Caprimulgus virginianus), as the truest harbinger of spring. Accordingly, upon the arrival of this bird, they begin to plant the ground, with great assiduity.

* Amoenitates Academicæ. Vol. IV. Dissertatio LXVII.

† Botanic Garden. Part II. Canto I. Note.

Although *Calendaria Floræ* have never been very minutely attended to, except among civilized nations, it is a fact, that the time of leafing, flowering, fruiting, &c., of vegetables, are circumstances which greatly interest the people in the savage state of society. Thus, among our Indians, some of the months are designated by circumstances derived from the state of vegetation in their country. These people have a "Strawberry-month", a "Mulberry month", &c. Others of the months have received their names from the time of the flowering of particular vegetables, especially the Common Dog-wood (Cornus florida), which contributes so much to beautify our forests with its fine large white involucres, early in the spring. The Chikkasah and Choktah Indians call the Spring-season, *Otoolpha*, from *Oolpha*, the name in their language for a bud, or to shoot out. The Cheerake-Indians denominate the autumn, *Oolekhoste*, "the fall of the leaf". Some of the more northern tribes say, that the proper time to plant the Indian-corn is when the Wild-Plumb (Prunus canadensis) blooms. Some of the tribes plant their corn when the leaves of the White Oak (Quercus alba) have attained the size of a squirrels ears. It would be easy to mention many other circumstances of this kind, all calculated to show, that "the agricultural rules of savage nations are fre-"quently founded, in a great measure, upon the fron-"descence, together with the time of flowering of dif-"ferent vegetables, indigenous in their countries*".

Nor are the Indians inattentive, in their calendars, to a great variety of circumstances, derived from the

* See page 63.

animal kingdom. Thus, the Carolina-Indians called one of their months " the Herring-month", from the time of the arrival of this species of fish in the rivers of their country. Some of the more northern Indians call August the " Sturgeon-month", because during this month, they catch a great abundance of sturgeons (Acipenser). To November, they give the name of the " Beaver-month", because very generally in this month, these animals, having collected a sufficient store of winter-provisions, take shelter in their houses. Extending their observations to still smaller objects, the Indians call March " the Worm-month or Moon", because at this season many species of minute animals (principally insects) leave their retreats in the bark of trees, in wood, &c., where they have passed the winter-season, in a state of great inaction or torpidity. Many other examples of the like kind, might be mentioned. But this is not the proper place to dwell upon the subject.

The following lines from Virgil, are calculated to show, that the Romans had paid great attention to the appearance of certain birds of passage, as a guide to them in their agricultural rules :

" Nec tibi tam prudens quisquam persuadeat auctor
" Tellurem borea rigidam spirante moveri :
" Rura gelu tum claudit hiems, nec semine jacto
" Concretam patitur radicem affigere terræ.
" Optima vinetis satio, quum vere rubenti
" Candida venit avis longis invisa colubris ;
" Prima vel autumni sub frigora, quum rapidus sol
" Nondum hiemem contingit equis, jam præterit æstas".

Georgic. Lib. II. l. 315-322.

" Dare not to plant when wint'ry Boreas blows,
" Leave sullen earth in undisturb'd repose:
" Shrunk are her frozen pores, and, clos'd with cold,
" Forbid the root to pierce th' unyielding mould.
" Wait, till, returning on the gale of Spring,
" The snake-fed bird * unfolds his silver wing,
" Or the slope sun his flying axle speeds,
" And, ere bleak Winter, Autumn chills the meads."

SOTHEBY.

CALENDARIA FLORÆ, if they be properly kept, form some of the most interesting notices in the natural history of a country. They form, next to the living, the best, picture of the country. They show us, in the most beautiful and impressive manner, the relations of the vegetable and the animal kingdoms to each other, and to the various agents by which they are surrounded, and by which they are affected. They enable us to compare together the climates of different countries or places, which are included within nearly the same latitudes, such as Florida and Palestine, Philadelphia and Pekin, New-York and Rome, not to mention many others. In the hands of future ages, they will be deemed among the most precious monuments of natural history that can be bequeathed by an inquisitive and enlightened people. For, to apply the observation to the countries of the United-States: if our climates have (as is by many asserted) already undergone considerable changes†, our winters in particular becoming much more mild and open, will it be doubted, that a great al-

* The Stork.

† Whether, however, this change has actually taken place in the United-States, is, in my opinion, a very doubtful point I shall not omit to examine this question in my " Comparative estimate of the climates of North-America and of Asia, within the same parallels of latitude".

teration is to take place in respect to the periods of the germination, the frondescence, the flowering, the defoliation, &c., of many of our vegetables? And as the migrations of birds are essentially governed by the state of the climate, which governs vegetation, and the changes of insects, will it be doubted, that the seasons of the movements of our birds may, at some future period, be essentially varied from their present ones?

One of the most complete specimens of a *Calendarium Floræ*, is that by A. M. Berger, in the *Amoenitates Academic**. Since the first appearance of this specimen, several calendars, upon the same, or nearly the same, plan, have been published in many of the countries of Europe. Of these I must particularly notice, *The Naturalist's Calendar*†, by the late Rev. Gilbert White, of Selborne, in Hampshire (England). This is a very interesting morcel of the kind, which I would recommend to the perusal of those who may wish to amuse themselves in similar essays.—We have, also, a valuable calendar, entitled "Indications of Spring," by another English writer, Robert Marsham, Esq. F. R. S. It contains the author's observations made during near half a century‡. This calendar proves, that there is a much greater analogy between the climate on the east coast of Britain, in the county of Norfolk, and that of Philadelphia, in regard to the leafing and flowering of certain vegetables, the first appearance of Swallows and other birds, &c., &c., than might be imagined.—My friend, the late Professor Walker§, of Edinburgh, kept a Calendar at Moffat, in

* Vol. IV. Dissertatio LXVII. † London: 1795.

‡ Philosophical Transactions. vol. lxxix. For 1789. Part ii. art. xiii.

§ I cannot omit this opportunity of paying a tribute of grateful respect to the memory of this excellent man. During my residence in Edinburgh, I received many marks of kindness and attention from him. Never, indeed, can I forget the

Scotland, during the year 1779. In this calendar, he remarked, that the North-American native plants vernated sooner than the indigenous trees of the island. He observed, that the Pear-tree (Pyrus communis) blossoms at Moffat nearly a month earlier than it does at Upsal, in Sweden. I find, that the difference of the time of flowering of this tree, at Philadelphia and Upsal (about twenty degrees of latitude) is nearly thirty-five days.

I HAVE published a specimen of a Calendarium Floræ, adapted to the vicinity of Philadelphia*. I have, also, collected materials for a much more complete work of this kind, which it is my intention to publish, on some future occasion.

hours, invaluable to me, which I passed in the company, and at the hospitable board, of the Reverend Dr. Walker. In him, more than in any other man I have known, were united an extensive acquaintance with natural history, and that innocent and almost infantine simplicity of manners, which so frequently characterize real genius, and the pure enthusiasm of love for the study of nature. Though I never attended the lectures of Dr. Walker, yet I may, with great propriety, consider him in the light of a *Preceptor*, as well as a *Friend*. All our conversations related to subjects of natural science: and while I, at that time a mere uninstructed tiro in natural history, could do little more than communicate an occasional *fact*, nothing could be more instructive than the various converse of the learned and amiable Professor.

* See Fragments of the Natural History of Pennsylvania. Part I. pages 1-10 Philadelphia: 1799.

SUPPLEMENT

TO THE ARTICLE CALENDARIUM FLORÆ.

THE following specimen of the CALENDAR of one of the more cultivated of the Indian tribes of the great tract of country now within the limits of the United-States, will not be deemed incurious or unimportant.

THE Onondagos, one of the Six-Nations, whose chief residence ever since the arrival of the Europeans in this country, has been in the state of New-York, divide the year into twelve months, and begin *their* year with December*. The names of the months are as follow: viz.

CHE-TÓ-RE.	December: "the cool month."
CHE-TÓ-RE-KO-NAH†.	January: "the cold month."

* The Onondaga year does, certainly, consist of twelve months; and these months, I am pretty certain, are *lunar*. In the language of this tribe of the Confederacy, a month is called *Weighneeta*, which is the name the Oneidas, who are close neighbours of the Onondagos, and who speak a near dialect of the same language, give to the *Moon*.—I do not mean, however, to assert, that the Indian months, which I have mentioned, exactly correspond to the months of *our* calendar.—On the subject of the manner of dividing time among the Indians (as well the rude as more cultivated) of North-America, I have collected some important information, which I shall communicate to the public, at a future period. At present, I shall only observe, that from the neat and simple Calendar of the Onondagos, it is easy to perceive, that they were more of an *agricultural* people than many of the other American tribes; than those, perhaps, who had a "Herring-month," a "Sturgeon-month," and a "Beaver-month," in their enumeration of the year. See page 299. And the Six-Nations, of whom the Onondagos formed a part, and a noble part, were, it is known, much more attached to the cultivation of the earth, than the Delawares, and many other tribes.—From this Calendar, it is also natural to infer, that the Onondagos have, for a very considerable length of time,—for several centuries at least,—been settled nearly in the same tract of country, or upon the same parallel of latitude,—in which they now reside. If, as I suppose, they came from the south-west, they must have altered, and accommodated, their calendar to the more northern regions of which they took possession.—The Mexicans, we are informed, made a considerable change in their calendar, when, migrating from the northern Atzlan, they seated themselves in the milder and more southern, and more happy clime, of Anahuac.

† The meaning of *Konah* seems to be, "in reality," or "in great earnest."

TIS-SAH.	February: "the snow is *beginning* to pass away."
TIS-SAH-KO-NAH.	March: "the snow is now gone in reality;" or is fast going.
KONE-LA-TOCH-AH.	April: "the Bud-month;" or the trees begin to leaf.—FRONDESCENTIA.—See p. 63.
KONE-LA-TOCH-KO-NAH.	May: "the Leaf-month;" the leaves being fully out.
EE-SET-AH.	June: "the Corn-month;" the Mays, or Indian-corn, being come up; and fit for the *first* dressing.
EE-RA-KO-NAH.	July: "the Corn is up in full," and fit to receive its *second* dressing.
HUS-HESS-KO-HAH.	August: "the Corn is making its heads;" or ears.
KOS-HESS-KO-HAH.	September: the month when "the ear is full," or fit for boiling.
KAN-TAH-HAH.	October: the month when "vegetation begins to fall away;" being affected by the frost.—It may be called the month of DEFOLIATION.—See pages 64 and 65.
KAN-TAH-HAH-KO-NAH.	November: the month when the "vegetation is chiefly fallen down;" having been killed by the frost.—Evergreens (see page 65), of which the number of species in the country of the Six-Nations, is very considerable,—such as Pinus, Larix, Abies, Thuja, Cupressus, not to mention the smaller, but yet conspicuous, Taxus, Rhododendron, Kalmia, and many others,—are, doubtless, intended to be excepted from the observation, which is exclusively restricted to *deciduous* vegetables, and chiefly those of an *arborescent* stature.

ADDITIONAL

NOTES AND ILLUSTRATIONS

TO THE FIRST PART.

Page 18. "IT is highly probable, that, in many instances, parasitic plants injure their supporters, more by emitting from their bodies some noxious fluid, than by absorbing wholesome fluids from the supports." Actual experiments, however, made with some of the parasitic plants, have very satisfactorily proved, that these plants derive a considerable portion of their nourishment from the vegetables which support them. The stem, the leaves, &c., of the Missletoe may be beautifully coloured by diluted Poke juice, and other colouring matters, through the medium of the branches of the Apple, the Gum (Nyssa), or other tree, from which the parasite proceeds. In this experiment, the Missletoe is not brought into *immediate* contact with the colouring juice: it becomes painted, if I may use the expression, by the juice which, having been previously absorbed by the stock, is from this taken up by the radicles of the parasite, which are intimately intermixed with the woody part of the supporting vegetable.

THE Tillandsia usneoides, or Long-Moss, is only found, in a vigorous state, upon *living* vegetables; and it is never seen alive upon trees which have been dead *more than one season*. This fact plainly shows, that the Tillandsia derives a large share of its nutriment from the vegetables upon which it grows.

THERE can be very little doubt, however, that some parasitic plants derive a large, if not the principal, part of their nourish-

ment from the atmosphere. This is, probably, the case with the wonderful Aerides odorata, of which Father Loureiro has given an account. This vegetable, which Willdenow calls Epidendrum flos aëris, is a native of the woods of Cochinchina and of China. It adheres to the trees, by means of a great number of long, linear, radical bulbs, from which it might be conceived to derive its nourishment, if Loureiro did not inform us, that when brought out of the woods, and hung up in the house, without having any connection with the earth or water, it continues, in this situation, during many years, to grow, to flower, and to germinate, exhaling a delightful odour. I shall quote the author's own words, as the book in which the fact is related, is probably in the hands of but few of my countrymen. "Mirabilis hujus plantæ proprietas est, quod ex sylvis domum delata, et in aere libero suspensa, absque ullo pabulo vegetabili terreo, vel aqueo in multos annos duret, crescat, floreat, et germinet. Vix crederem, nisi diuturnâ experientiâ comprobassem*."

Page 24. To the terminology of caulis, I beg leave to add, *caulis floriferus*, a flower-bearing stem. We have a fine example of this in the beautiful Cercis canadensis, or Canadian Salad-tree; called also Shad-blossom. The trunk, as well as branches, is covered over with tufts of the rose-coloured blossoms: a circumstance which adds much to the beauty of the tree, especially as its leaves do not make their appearance until the flowers have begun to fade or disappear.

Pages 25, 26. "The culm sometimes consists of a number of scales, which lie over each other, in the manner of tiles upon a house."—I think it has not yet been ascertained what culm, if any such exist, Linnæus here alludes to. A *culmus imbricatus* is unknown to the botanists. It is possible, that Linnæus had his eye upon some figure of the stem of a Palm.

Pages 26, 27. Linnæus has observed, that the "scapus is only

* Flora Cochinchinensis: sistens plantas in regno Cochinchina nascentes, &c. labore ac studio Joannis de Loureiro, &c. tom. ii. p. 525. Ulyssipone: 1790. 4to.

a species of pedunculus." "The term, says Dr. Smith, might therefore be spared, were it not found very commodious in constructing neat specific definitions of plants. If abolished, *Pedunculus radicalis*, or radical flower-stalk, should be substituted*."

I CANNOT agree in sentiment with Linnæus and Dr. Smith. The term *scapus* cannot well be spared: its *origin* emphatically distinguishes it from the *pedunculus*, with which, in describing plants, it ought never to be confounded.

A PHYSIOLOGICAL circumstance concerning the scape deserves to be mentioned here. The Swedish naturalist thought, "that a plant could not be increased by its scapus." But Dr. Smith "has had scaly buds form even on the flower-stalk (scapus) of Lachenalia tricolor, *Curt. Mag. t.* 82., whilst lying for many weeks between papers to dry, which, on being put into the ground, have become perfect plants, though of slow growth." *Introduction*, &c. page 112. Is the *true* pedunculus capable of continuing a plant? I have not determined the point by actual experiment: but I have little doubt, that the peduncles of *many* plants, as well as the scape of Lachenalia, is capable of forming buds, or bulbs (*propagines*), from which a plant similar to the parent, may be evolved.

Page 28. WILLDENOW has totally omitted *frons* in his list of stems, or trunks. I think this is right. He retains stipes: and he thinks proper to consider the *pedunculus* and the *petiolus* as species of stems. So does Smith.—The first of these writers restricts the term *caulis* to the herbaceous vegetables: and he employs *truncus* to designate the stem of the trees and shrubs. His truncus is two-fold: viz. 1. *truncus arboreus*, that has a crown of branches at top: and 2. *t. fruticosus*, that has branches also below. I am not confident that this distinction is of much consequence.

MR. WILLDENOW adds two species of stem to the list: viz. *Surculus*, and *Seta*.

* Introduction, &c. page 129.

1. The Surculus, or Shoot, is the stem which bears the leaves of the mosses. This is either, 1. *simplex*, simple; having no branches, as in Polytrichum: see our Plate xxxi. 2. *ramosus*, branched; dividing into branches, as in Mnium androgynum. 3. *ramis deflexis*, with hanging branches; when the stem is branched, but all the branches hang down, as in Sphagnum palustre. 4. *decumbens*, decumbent; that lies on the ground. 5. *repens*, creeping: and, 6. *erectus*, upright.

2. The Seta, or Bristle, is that species of stem, which in the mosses supports only the fructification, without leaves†. It is always simple, and never branched, as in the preceding species. The seta is sometimes, 1. *solitaria*, solitary. 2. *aggregata*, aggregate; or crowded. 3. *terminalis*, terminal; on the point: or, 4. *axillaris*, *vel lateralis*, on the side.

Pages 40, 41. *For* as in different species of Nymphaea, &c., *ending* or Map-apple, *read*, as in the majestic Nelumbo lutea, which adorns some of the wet meadows in the vicinity of Philadelphia; in the Tropaeolum, or Indian-cress; in the Geranium peltatum; the Podophyllum peltatum, or May-apple; the Hydropeltis purpurea (See Plate xxxii. Fig. 12.) the Diphylleia cymosa, figured by Michaux, *Flor. bor. amer. tom.* i. *tab.* 19, 20., and in many others. 2*. A leaf is said to be centro-peltate, *folium centro-peltatum*, when the foot-stalk is inserted directly, or nearly, in the centre of the leaf, as in the Nelumbo and Hydropeltis, just mentioned.

Page 41. *For* as in many Grasses, Polygonum, Rumex, &c., *read* as in many Grasses, in Polygonum, and not a few of the plants belonging to the family of the Orchides‡.

† It may be said to be the scapus of the mosses. See Plates xxx and xxxi.

‡ Among the number of *fulcra*, or props, Mr. Willdenow enumerates the *Vagina*, or Sheath: this he defines "the prolongation of a leaf, which rolls itself round the stem, and thus forms a cylinder, to the opening of which the leaf is attached, as in Polygonum, and all the Grasses." Principles, &c. page 49.

Page 51. One of the earliest opinions which seem to have been advanced by the naturalists concerning the uses of the leaves of vegetables, is that of Andreas Caesalpinus. In his work *De Plantis*, first published in 1583, this celebrated man, to whom both natural history and medicine are indebted for the discovery or promulgation of many important truths, imagined, that the leaves were merely a kind of clothing, or a protection of the vegetable against the influence of cold and wet. The Italian philosopher supposed, that the solar influence being weakened in its passage through the leaves, was thus prevented from acting with so much violence as it otherwise would, upon the fruit and young buds. "Accordingly, he observes, many trees lose their leaves in autumn, when their fruits are perfected, and their buds hardened, while such as retain the fruit long, keep also their leaves; even till a new crop is produced, and longer, as in the Fir, the Arbutus, and the Bay. It is reported, he adds, that in hot climates, where there is almost perpetually a burning sun, scarcely any trees lose their leaves, because they require them for shade."

There is, unquestionably, some foundation for these observations; and in particular, I think, for that part of the theory which ascribes to the leaves *a protecting power from the influence of the sun's rays*. It would not however, if I mistake not, be difficult to mention a considerable number of trees which lose their leaves even in, or near, the torrid zone. On the other hand, many trees and shrubs drop their leaves before the winter season, though their fruit is not yet perfected; and consequently it is exposed to all the rigours of a cold climate. This is the case with many North-American Oaks, with the Franklinia Americana, the Gordonia Lasianthus, Hamamelis Communis, and many others, which require an entire year to bring their fruits to perfection.*

* Some vegetables bear the loss of their leaves, by whatever means effected, tolerably well. This is especially the case with the White Mulberry (Morus alba), the leaves of which may be repeatedly plucked by the hand, in the course of the same year: and we often see, in Pennsylvania, a third, and sometimes a fourth, crop of leaves upon our Elms, in consequence of the depredations of the pernicious little coleopterous insect, which proves so destructive to them in our streets, gardens, &c. S S

Page 52. The quantity of perspirable matter which is thrown off from some plants, and especially, perhaps, from their leaves, is almost incredible. If we may believe Dr. Hales, the great annual Sunflower (Helianthus annuus), that magnificent vegetable, which was cultivated by the Indians of America, from Peru to the great lakes of Canada;—if we may depend upon Hales, the Sunflower, perspires about seventeen times as fast as the human skin, in its ordinary functions of perspiration. Another vegetable remarkable for the rapidity and greatness of its perspiration, is the beautiful Hydrangea Hortensia, now so common in the United States, where it stands even the rigours of our winters: in Pennsylvania at least. Some species of Rose also perspire very largely.* But it has been thought, that hardly any plant performs the function of perspiration so extensively as the Cornus mascula, or Cornelian Cherry. According to Du Hamel, the quantity of fluid which is evaporated by the leaves of this vegetable, in twenty-seven hours, is almost equal to twice the weight of the whole plant.† Is the perspiration of the North American species (which are numerous) of the genus Cornus, peculiarly great?

The matter of perspiration of plants, is very various in different genera and species. Sometimes, it may be considered as a mere insipid water. We have seen this perspiration in the Weeping Willows (Salix babylonica) of Philadelphia, to such a degree, that the brick pavements have been wetted by them, as though by a shower of rain. The leaves of Orange-trees sometimes perspire a saccharine matter, and so do some Solanaceous plants. Cistus creticus, of the Greek-islands, perspires a resinous matter, the Labdanum of the shops,‡ which is collected by beating the shrub by means of leather straps.§ Dictamnus albus, called Fraxinella, exhales an inflammable vapour, which catches fire when a taper is applied to it.

* Rosa.

† Phisique des Arbres, &c. tom. i. p. 145.

‡ See Part III. page 69.

§ See Tournefort's Voyage to the Levant. English translation, vol. i. p. 79—82. London: 1741.

THE leaves, as well as the fruit of many vegetables, perspire, or perhaps more properly secrete, a waxy matter, which may easily be discovered upon their surface. The fine glaucous covering of many Plumbs, and other fruits, is certainly of this nature.

THE perspiration of plants, like that of animals, is influenced by a variety of circumstances, a few only of which I shall mention here: viz. different conditions of the atmosphere; not only in regard to heat and cold, dryness and moisture, but also, if I mistake not, a greater or lesser degree of electricity. Plants perspire more or less according to their state of vigour, as we daily observe in the management of our flower-pots. Lastly, the perspiration of plants is essentially increased by subjecting them to the influence of stimulating agents, such as camphor, nitre, and the like, as I have had particular occasion to observe in regard to the Liriodendron Tulipifera, &c.—See *Transactions of the American Philosophical Society*, vol. 4.

IT is a circumstance not unworthy of being mentioned, in an history of the real and supposed uses of the leaves, that many savage nations seem to consider these organs as the *hairs* of vegetables; at least of trees and shrubs. The Muskohge, or Creek-Indians, call the leaf *Ito-esse*, which is literally "the hair of the tree:" and nearly the same idea prevails among certain Indians of South America, and the West India islands. Thus the Caraibees gave the same name, viz. *Toubanna*, to a leaf and a *feather*.

Page 65. THE various colours which the leaves of vegetables assume in the autumn, prior to their fall, have been supposed by some eminent chemists, to depend upon the absorption of oxygen. How far is this hypothesis well founded? Are the autumnal colours of the same species of vegetable, inhabiting different portions of the globe, in nearly the same parallel of latitude, the same? Laurus Sassafras is said to inhabit Cochinchina; Juglans nigra and Bignonia Catalpa, Japan.

Page 66. IT has been very justly observed, that some vege-

tables are by their very nature, or the structure of their parts, perdifoils, or deciduous. This is the case with the two species of Platanus, or Plane-tree, that are now known to us. Thus in the Platanus occidentalis, one of the most majestic and common of the North American trees, the buds are concealed in the end of the petiole, and as they increase in size, they unavoidably force off the leaf, the petiole of which is now dilated at its origin, assuming a funnel-like appearance. In this funnel or cavity, the bud was concealed. This Platanus (called in the United States Button-wood, or B. tree, Sycamore, and Water-Beach) is by this structure of its buds, absolutely a perdifoil. The leaves fall off in the latter end of October, at which time we sometimes find the cavity at the end of the petiole, large enough to admit the end of the little finger: and it is almost impossible to see a single leaf remaining upon any of these trees in the winter-season. The same structure of the petiole occurs in other vegetables, which, for the same reason, are perdifoils; such as the Virgilia, or Yellow-wood, a tree of Tennessee, and other western parts of North America. In different species of Rhus, or Sumach, the fall of the leaf is not so determinate, though here also the nascent bud presses upon the petiole. But in the Sumach, the pressure of the bud is oblique; and consequently the petiole is not so readily forced off.

Page 85. ACCORDING to Mr. Willdenow, the thorn "arises most generally from an incompletely evolved bud, which has began to form itself, but wanting a proper supply of nourishment, remains only in form of a very short, sharp, and bare twig. It is, like the woody stem of a tree or shrub, formed of the air and adducent vessels, which have grown completely hard. It therefore remains fixed, though the bark be taken off." *Principles*, &c. p. 270, 271. We often see one or more leaves proceeding from a firm and rigid thorn; which, in process of time, becomes a flowering branch. Some plants, however, hardly ever part with their thorn entirely: such as Buckthorn. And I have not yet learned, that the rigid thorn of Gleditsia triacanthos ever becomes a frondose stem. Cultivation never converts a prickle into a shoot.

EXPLANATION OF THE PLATES

ANNEXED TO THE FIRST VOLUME.

WITH

MISCELLANEOUS FACTS AND OBSERVATIONS.

PLATE I.

FIG. 1. THE principal figure on this plate may serve to illustrate the XIIIth class, or Polyandria, and the first order of the class, or Monogynia. It is the figure of the Sarracenia purpurea, or Purple Side-Saddle-flower: known also by the names of Hollow-leaved Lavendar, Water Brash, &c. I have already made mention of this very singular plant in former parts of these *Elements*, see pages 34, 87, 88. [A. Represents one of the hollow leaves, (*folium tubulosum*, or as Willdenow calls it, *ascidium*), cut off at the end. B. The scape (*scapus*), supporting the flower, C. D. E. F. This is an anterior view of the flower. C. E. Two of the five petals. D. One of the leaves of the superior perianth (*perianthium superius*). F. The peltate or target-shaped stigma (*stigma peltatum*). G. One of the leaves of the superior perianth. H. The inferior perianth, which consists of only three leaves (*perianthium inferius*, *triphyllum*), whereas the superior perianth is pentaphyllous, or consists of five leaves (*pentaphyllum*). I. A scape supporting the parts of the flower K. L. M.—K. The receptacle (*receptaculum*). L. The germ (*germen*). M. The peltate stigma.

THE plant is represented nearly of its natural size; though we often see specimens considerably larger, and not a few some-

what smaller. The drawing is correct, and will convey a satisfactory idea of the plant, which is, on many accounts, one of the most interesting in North-America.

ALL the leaves of the Sarracenia purpurea are radical (*folia radicalia*), and hollow, each forming a kind of funnel, or rather bottle, the form of which will be better understood by an inspection of the plate, than by the most studied description. The young leaves are quite closed at the top, and it is only as they advance in size and age, that they become pervious. The inside of the leaf is generally beset with innumerable fine processes, or setæ, the points of which look *downwards:* but these setæ are principally observed about the upper constricted part of each leaf, which may be called its neck, and which is distinctly visible in the two principal leaves, on the right and left of the drawing. The use of these setæ will afterwards be hinted at.

THE Sarracenia purpurea is never found in *uniformly* dry ground, but almost always in boggy ground, and sometimes in ponds of water of some depth. In this latter situation, we sometimes find it with its roots hanging loose in the water, entirely unconnected with the ground.

WHEREVER we find the plant, its leaves (the *older* ones) almost constantly present to us two interesting phenomena: They contain a quantity of water,—and this even in the dryest weather, when neither rains nor visible dews have fallen;—and a number of insects, generally small, and almost always dead. It is these two circumstances which render the Sarracenia an object of curiosity among botanists, and especially among the physiological botanists.

WHAT is the use of this structure of which I have been speaking? Why have the leaves been formed hollow? And why do we so generally find insects in them? I shall not pretend to give satisfactory answers to these questions; but the subject is two curious not to demand the offering of a conjecture.

I FORMERLY imagined, that as the Sarracenia is destined to grow in wet places, which, however, are liable, at times, to become nearly dry, so the hollow leaves, or *ascidia*, are intended to serve as reservoirs (*hydriæ*) of water, that the plant may not suffer from a deficiency of its favourite and most indispensible aliment, in the hotter weather, or when there has been a long-continued drought*. But various circumstances induce me to relinquish this idea: for the younger leaves, to whose growth and health water must be peculiarly necessary, are, as I have already said, impervious, and contain no water: and, again, the plant when it grows *in* the water,—that is in situations not liable to become dry,—and where of course it cannot stand in need of the apparatus of reservoirs; I say the ascidia, even in this situation, always contain a portion of water. These circumstances alone would almost induce me to relinquish my former theory: and I may add, that the Sarracenia purpurea is much less frequently found in grounds, even occasionly dry, than I had imagined. I have not yet made the experiment, but the experiment would I think show, that our plant would flourish very well, were we to close the openings of the ascidia, and completely prevent them from receiving any supply of water from *external* sources.

MR. CATESBY seems to have formed to himself an hypothesis of the use of the hollow leaves of the Sarracenia. Speaking of Sarracenia purpurea, he says, "The hollow of these leaves, as well as of the other kind (Sarracenia flava), always retain some water; and seem to serve as an asylum or secure retreat for numerous insects, from frogs and other animals, which feed on them†."

As the insects which are observed in the hollow leaves, or bottles, of these plants, are very generally found dead, we can scarcely call them "secure retreats." Nor are the leaves too

* This appears to have been the opinion of Linnæus.

† The Natural History of Carolina, Florida, and the Bahama Islands, &c. Vol. ii. page 70. tab. 70.

small to prevent some of the smaller frogs, should they think proper, from making their way into them. Indeed, if I do not mistake, the American tree-frog (Hyla americana) is not unfrequently found in these leaves.

But the following fact plainly proves, that the insects that have taken up their residence in the *ascidia* are by no means safely protected from the attacks of certain animals.

Sarracenia variolaris of Michaux (*Flor. bor. amer. tom.* i. *p.* 310.) is furnished with tubular leaves, like the other species of the genus. The leaves of this species, which is a native of the swamps of Georgia and Carolina, contain great numbers of insects. The fact is not unknown to various species of birds, especially to the Brown Thrush, or French Mocking-Bird (Turdus rufus), and other birds belonging to this and other genera of the order of the *passeres*. It is common to see numbers of these birds collecting about the Sarracenia, with no other *known* view than to procure the imprisoned insects. They pick holes in the leaves, and then slit them for some distance, and thus readily obtain their prey. They cannot obtain their prey through the mouths of the ascidia*.

This fact is well attested. Nor will it be deemed one of the least interesting in the history of the instincts of the class of birds! Although I have not, hitherto, learned, with any certainty, that birds in like manner frequent and dissect the leaves of other species of Sarracenia, besides Sarracenia variolaris, I have no doubt that all the other species of the genus, are in like manner visited and treated: and when we consider the great capacity of the leaves of Sarracenia flava, S. purpurea, &c., and the multitude of insects which they often contain, we may, with great propriety, call them store-houses of the food of birds.

* In like manner bees which cannot procure the honey through the mouths of various tubular corollas, slit the tubes, and thus obtain the honey. This is the case with Azalea nudiflora, A. viscosa, &c.

FUTURE observations will, no doubt, show us, that different species of Nepenthes, the Aquarium sitiens, and other similar plants, are, in like manner, subservient to the nourishment and support of birds. But I do not mean to insinuate, that these various plants were furnished with *hollow* leaves, *merely* to satiate the appetite of birds: and yet I could as soon believe this, as agree, with a certain learned botanist, from whom I am often compelled to differ in sentiment, that the nectar of plants is of no other use to them, than in so far as it may tempt insects to assist the impregnation of plants*.

THE same author seems to fancy, that he has discovered the final cause of this singular construction in the leaves of our Sarracenia. As the subject is certainly very curious, I shall devote some attention to it, reserving, however, a more ample investigation for a monographia of the genus Sarracenia.

AFTER observing, that "Linnæus conceived this plant to be allied in constitution to Nymphæa, and consequently to require a more than ordinary supply of water, which its leaves were calculated to catch, and to retain, so as to enable it to live without being immersed in a river or pond;" and after observing, that "the consideration of some other species renders this hypothesis very doubtful;" Sarracenia flava, and more especially Sarracenia adunca, *Exot. Bot.* t. 53, being "so constructed that rain is nearly excluded from the hollow of their leaves, and yet that part retains water, which seems to be secreted by the base of each leaf,"—what then (says the respectable President of the *English* Linnean Society) is the purpose of this unusual contrivance? An observation communicated to me two years ago, in the botanic garden at Liverpool, seems to unravel the mystery. An insect of the Sphex or Ichneumon kind, as far as I could learn from description, was seen by one of the gardeners to drag

* See page 153.—The same author says, "There can be no doubt,—!! no doubt!!—" that the sole use of the honey with respect to the plant, is to tempt "insects, who in procuring it fertilize the flower, by disturbing the dust of the "stamens, and even carry that substance from the barren to the fertile blos-"soms." Introduction, &c. page 270.

several large flies to the Sarracenia adunca, and, with some difficulty, forcing them under the lid or cover of its leaf, to deposit them in the tubular part, which was half filled with water. All the leaves, on being examined, were found crammed with dead or drowning flies. The S. purpurea is usually observed to be stored with putrefying insects, whose scent is perceptible as we pass the plant in a garden; for the margin of its leaves is beset with inverted hairs, which, like the wires of a mouse-trap, render it very difficult for any unfortunate fly, that has fallen into the watery tube, to crawl out again. Probably the air evolved by these dead flies may be beneficial to vegetation, and, as far as the plant is concerned, its curious construction may be designed to entrap them, while the water is designed to tempt as well as to retain them. The Sphex or Ichneumon, an insect of prey, stores them up unquestionably for the food of itself or its progeny, probably depositing its eggs in their carcases, as others of the same tribe lay their eggs in various caterpillars, which they sometimes bury afterwards in the ground. Thus a double purpose is answered; nor is it the least curious circumstance of the whole, that an European insect should find out an American plant in a hothouse, in order to fulfil that purpose.

"If the above explanation of the Sarracenia be admitted, that of the Nepenthes will not be difficult. Each leaf of this plant terminates in a sort of close-shut tube, like a tankard, holding an ounce or two of water, certainly secreted through the footstalk of the leaf, whose spiral-coated vessels are uncommonly large and numerous. The lid of this tube either opens spontaneously, or is easily lifted up by insects and small worms, who are supposed to resort to these leaves in search of a purer beverage than the surrounding swamps afford. Rumphius, who has described and figured the plant, says, "various little worms and insects crawl into the orifice, and die in the tube, except a certain small *squilla*, or shrimp, with a protuberant back, sometimes met with, which lives there*."—I have no doubt that this shrimp feeds on the other insects and worms, and that the same purposes

* See, also, Pennant's Outlines of the Globe, &c. Vol. i. page 236. plate 9.

are answered in this instance as in the Sarraceniæ. Probably the leaves of Dionæa muscipula*, as well as of the Droserae, *Engl. Bot. t.* 867—869, catch insects for a similar reason†."

PLATE II.

Fig. 1. The bulb (*bulbus*, *s. radix bulbosa*) of the beautiful Atamasco-Lily (Amaryllis Atamasco), a native of the southern parts of the United-States. A. The bulb. B. B. Two offsets or suckers, from the lower end of the bulb. C. The radicle (*radicula*), which in the opinion of many writers is the only true root portion. Fig. 2. A tranverse section of the same bulb, intended to show its tunicated or coated structure. a. a. b. b. Two eyes, or places, from which proceed the flowers. c. The radicle. Fig. 3. The root of the Fumaria Cucullaria, commonly called Dutchman's Breeches. A. A. Two bulbs. b. b. Small succulent scales, protecting the lower parts of the bulbs, each of which is capable of becoming a perfect plant. This figure may be said to represent the grumose root (*radix grumosa*). Fig. 4. The fusiform root (*radix fusiformis*) of the Wild-Carrot (Daucus Carota). A. A. The main body of the root, or descending caudex, in the language of Linnæus. B. B. Mark the commencement of the ascending caudex, or stem. Fig. 5. The stem and root of a species of Orchis. The root may be called a palmated root (*radix palmata*). A. The principal body of it. B. B. The smaller succulent portions. C. The ascending caudex.

Fig. 6. The Cymbidium hyemale of Willdenow‡, commonly called, in some parts of the United-States, Adam and Eve. A. B. The two principal bulbs, constituting what Lin-

* See Plate vii, in vol. ii.

† An Introduction to Physiological and Systematical Botany. By James Edward Smith, M. D. F. R. S. &c. &c.—Page 195—198. London: 1807

‡ Ophrys hyemalis. See page 10.

næus calls the *bulbus duplicatus*, *s. testiculatus*. C. C. The smaller more fibrous-like portions of the root. D. The radicle. E. The plicated or folded leaf (*folium plicatum*). Fig. 7. The root and a portion of the stem of the beautiful Limodorum tuberosum of Linnæus (Cymbidium pulchellum of Swartz), which grows abundantly in the neighbourhood of Philadelphia. A. A. The radicle. B. C. Two small suckers. Fig. 8. The scaly bulb (*bulbus squamosus*) of the Lilium superbum. A. The radicle. B. The scaly portion. Fig. 9. The root, &c., of the Devil's Bit, or Veratrum luteum of Linnæus (Melanthium dioicum? of Walter.) It is a good example of the premorse, or abrupt root (*radix præmorsa*). A. The extremity of the root, which appears as if it had been off. B. The radicles. C. Portions of the leaves, which are all radical (*folia radicalia*), in this plant. Fig. 10. The granulated root (*radix granulata*) of the White Saxifrage (Saxifraga granulata). A. A. Granules of the root attached to the fibres, or radicles. Fig. 11. The horizontal root (*radix horizontalis*) of the May-apple (Podophyllum peltatum). A. The ascending caudex, or a portion of the stem. B. B. b. b. The main body of the root, as it creeps, or spreads, in an horizontal direction, under the ground. C. C. C. Fibres proceeding from the main root.—See Plate XVIII.

All the plants that are referred to in this plate are natives of the United-States, with the exception of the White Saxifrage, in Fig. 10. This is a native of many countries in Europe.

PLATE III.

Fig. 1. The root of Tuberous Moschatel (Adoxa Moschatellina. A. A shoot proceeding from the root. B. Continuation of the same. This is a species of tuberous root. See Part 1. page 7.—Fig. 2. Creeping Crowfoot (Ranunculus repens). A. A. The stem. B. B. radicles proceeding from the bosom of the leaves. Fig. 3. Common Pilewort (Ranunculus Ficaria). A. A. The stem. B. Bulbs in the axils (*axillæ*) of the

leaves. Fig. 4. The Common Onion (Allium Cepa). A. Bulbs in the umbel of flowers.—See Part 1. page 93.—Fig. 5. A branch of the Cardamine pratensis. A. A. Radicles shooting out from the leaves. Fig. 6. A species of Sheeps Fescue-grass, intended to show one of the modes by which plants increase. A. A viviparous shoot proceeding from the flower.—See Part 1. page 94. —Fig. 7. The strobile (*strobilus*) of the American* Larch (Pinus pendula of Aiton). Fig. 8. A view of the inner side of one of the scales, which compose the strobile, with the seed attached to it. Fig. 9. A single, detached seed, with its wing, or *ala*.

Among the bulb-bearing plants of the United States, I may mention a very common plant, growing in marshy situations, and easily procured by the student in the vicinity of Philadelphia, &c., where it flowers in June and July. I mean the Lysimachia bulbifera of Curtis, *Bot. mag. n.* 104, the L. stricta of other writers.† The bulbs, which are placed in the axils of the leaves, are attenuated at both ends, and are often near half an inch long. By these *gemmæ vivaces*, the plant is readily propagated.

A still more interesting bulbiferous plant, is a beautiful species of Begonia, from China, which I have had, in my green-house, for some years. The short egg-shaped bulbs are axillary, and smooth and shining. Even in the green-house, the leaves, stem, and root, perish; but in the winter, and especially in the early spring, the surface of the pot, is found covered over with the bulbs, which rapidly vegetate, even upon the surface of the earth.

* Larix (*americana*) foliis brevioribus: strobilis parvis, ovoideo-subglobosis; squamis paucioribus. *Michaux, Flora, Boreali-Americana. tom.* ii. 203.

† Viscum (*terrestre*) caule herbaceo tetragono brachiato, foliis lanceolatis. *Linn. Sp. pl.* ii. *p.* 1452. Linnæus, who had no opportunity of seeing the fructification of this common American plant, has thrown out a suspicion that it might be a species of Loranthus!

Bryophyllum calycinum of Salisbury (*Parad. Lond.*) Cotyledon rhizophylla of Roxburgh), a native of India, vegetates principally by the little bulbs, which are placed in the crenatures of the very succulent leaves. These bulbs are not to be discovered by the naked eye, though by laying the leaf upon the earth, the new plant is observed to proceed only from the *crena*. By placing the leaf between blotting paper, and keeping it there for some time, the bulbs are disengaged, and are easily seen. The plant is very tender, and must be kept (in Pennsylvania), during the winter, in a hot house. But during the summer season, even in the open air, it vegetates with great rapidity, even upon the most arid gravel walks.

PLATE IV.

THIS plate is entirely appropriated to the beautiful American Painted-cup (Bartsia coccinea), which grows abundantly in Pennsylvania, and many other parts of the United-States. A. A. A. A. A. A. The large and crimson coloured bractes (*bracteæ*), which are much more painted than the corolla, or the calyx. B. B. B. The perianth. C. A perianth. D. d. The corolla. E. A portion of a corolla turned downwards, to show the four stamens and the style. F. The four stamens, two of which are lower than the other two. G. The pistil. H. The pericarp, which is a capsule, two locular or celled (*capsula bilocularis*) and two valved (*bivalvis*). I. The capsule opened, with the contained seed.

THIS Plate may serve to illustrate the class of Didynamia, and the order of Angiospermia.—See Part I. pages 78—82.

PLATE V.

A. B. C. D. F. Representations of the Common Garden-Bean (Vicia Faba). A. The bean, covered with its husk (*cutis*). 1. The hilum, scar, or eye. 2. 3. The umbilical cord (*funis umbilicalis*) by which the bean was attached to the scar, and to the legume, or pod. 4. The small foramen or hole, through which a part, at least, of the fluid seems to enter the bean. See page 200.* B. The bean deprived of its husk. 1. The radicle. C. One half the bean, or a single cotyledon. 1. The husk. 2. Vessels. 3. 4. The embryo. D. The husk. 1. Showes where it is thickest. 2. Shows in what manner the embryo is contained within the duplicature of the husk. F. The two cotyledons, showing the vascular structure upon their surface. 1. 1. 2. 3. The embryo or corcule. 2. The plumule (*plumula*). 3. The radicle(*radicula*). E. One half of a dry

* This foramen in vegetables, has lately received the name of *micropyle*, from Mr. Tupin, an ingenious French botanist, and most accomplished painter of plants.

Bean. 1. The radicle. 2. The duplicature. 3. 3. The cotyledons. G. One of the lobes or cotyledons of the Kidney-Bean. 1. The embryo. H. The same when further advanced in growth. 1. The seminal leaves *(folia seminalia)*, or plumule developed into leaves. 2. The radicle. I. A Kidney-Bean. i. The hilum. K. The kernel *(nucleus)* of the Filbert-nut (Corylus Avellana). L. One of the lobes of the same. i. The embryo. M. The seed of the Common Persimmon (Diospyros virginiana). N. One of the lobes of the same, with the embryo of its natural size. O. A magnified view of the same embryo, exhibiting the beautiful vascular structure of the plumule. See Part 1. pages 231, 233, &c.

PLATE XXXII.

This plate contains representations of a number of the principal forms of *Simple* leaves, drawn for this work by an eminent artist*, from actual specimens, no imaginary forms being admitted. The greater number of the vegetables whose leaves are here represented, are natives of the United-States: all those, indeed, of whose native country nothing is said.

Fig. 1. *Folium lineare:* Aster linearifolius. 2. *fol. subulatum:* Phascum subulatum. 3. *fol. lanceolatum:* Polygonum Persicaria. 4. *fol. ellipticum:* Magnolia glauca, common Magnolia, or Beaver-tree. 5. *fol. obovatum:* Arbutus Uva ursi. 6. *fol. cuneiforme:* Quercus nigra. N. B. This is the true Black-Oak, or Black-Jack, of the United-States, and must not be confounded with Quercus tinctoria, which is also called Black-Oak.—7. *fol. spathulatum:* Polygala lutea. 8. *fol. acutum:* Solidago odora. 9. *fol. acuminatum:* Cornus alterna, *seu* alternifolia. 10. *fol. setaceo-acuminatum:* Quercus Phellos, or Willow-leaved Oak. 11. *folium orbiculatum:* Glycine tomentosa. 12. *fol. peltatum:* Hydropeltis purpurea of Michaux: see page 308 of this work; and Ixodia palustris of Solander. 13. *fol. perfoliatum:* Uvularia perfolia. 14. *fol. conna-*

* Mr. Redoute, of Paris.

tum: Eupatorium connatum of Michaux: Eupatorium perfoliatum of Linnæus. 15. *fol. amplexicaule:* Conyza amplexicaulis; a native of the East-Indies. 16. *fol. auriculatum:* Magnolia auriculata. 17. *fol. cordatum:* Pontederia cordata. 18. *fol. obcordatum:* Oxalis acetosella. 19. *fol. emarginatum:* Astragalus emarginatus; a native of the East. 20. *fol. reniforme:* Asarum canadense. 21. *fol. sagittatum:* Polygonum sagittatum, called Tearthumb, and Turkey-seed. 22. *fol. hastatum:* Polygonum hastatum. 23. *fol. deltoides:* Populus nigra. 24. *fol. rhombeum:* Sida rhombifolia. 25. *fol. dentatum:* Populus grandidentata. 26. *fol. serratum:* Fagus Castanea. 27. *fol. duplicato-serratum:* Betula nigra, Linn. 28. *fol. crenatum:* Quercus Prinus, *monticola.*—This is the Chesnut-oak of Pennsylvania.—29. *fol. repandum:* Hydrocotyle . . . . . 30. *fol. undulatum:* Asclepias obtusifolia. 31. *fol. laciniatum:* Rudbeckia laciniata. 32. *fol. sinuatum:* Argemone mexicana. N. B. I must consider this as one of the indigenous plants of the United-States.—33. *fol. panduratum:* Convolvulus Imperati; a native of Egypt, Italy, &c. 34. *fol. lyratum:* Senecio lyratus. 35. *fol. runcinatum:* Leontodon Taraxacum, or Common Dandelion. See page 260. I now incline to consider this as truly indigenous in North-America.—36. *fol. lobatum:* Liriodendron Tulipifera, or Tulip-tree; called also Poplar, Canoe-wood, &c., &c.—37. *fol. palmatum:* Viola palmata. 38. *fol. trilobatum:* Anemone Hepatica. 39. *fol. palmato-lobatum:* Liquidambar Styraciflua, called Sweet-Gum, Bilstead, &c. See Catesby, *Carol.* p. 65. t. 65. 40. *fol. multipartitum:* Crysocoma corona. 41. *fol. pinnatum:* Proserpinaca palustris.

PLATE XXXIII.

This plate is wholly devoted to the forms of *Compound* and doubly-compound Leaves. The figures were done expressly for this work, by Mr. Redoute.

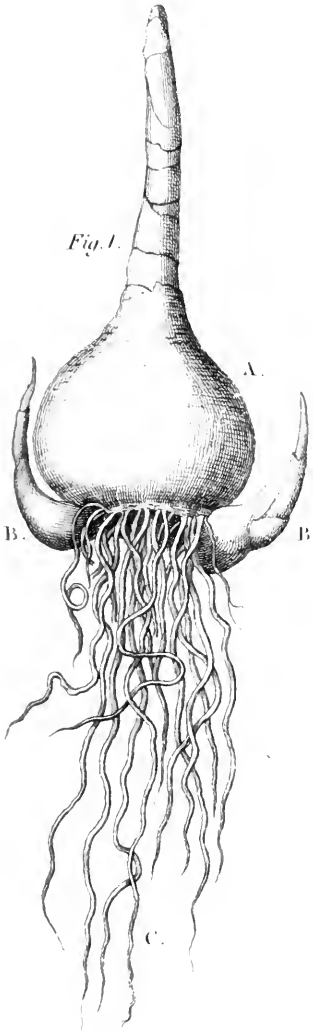
Fig. 1. *Folium conjugatum, vel binatum:* Zygophyllum Fabago; a native of Syria, Mauritania, Siberia, &c. 2. *fol. ternatum:*

Trifolium pratense, or Red-Clover, now very extensively *naturalized* in the United-States. 3. *fol. ternatum: foliis duplicato-serratis:* Spiraea trifoliata, or Indian Physic; see part III. page 59.—4. *fol. quaternatum:* Zornia tetraphylla. 5. *fol. digitatum:* Aesculus Pavia. See explan. of plate xv. fig. 3.—6. *folium digitatum; foliolis septenis:* Lupinus perennis, or Perennial Lupin, an extremely common plant in the vicinity of Philadelphia. 7. *fol. pedatum:* Helleborus foetidus: See Part III. page 71. 8. *fol. pedatum; foliis compositis:* Adiantum pedatum; called Maiden-hair, and Mow-hair. An extremely common, as well as beautiful, plant within the limits of the Botanical Excursions, in the neighbourhood of Philadelphia.—9. *fol. impari-pinnatum:* Juglans tomentosa, vel squamosa. This is the true Shell-bark Hickory.—10. *fol. abrupti-pinnatum:* Tamarindus indica; a native of the East and West Indies, of Egypt, and Arabia. 11. *fol. cirrhoso-pinnatum:* Pisum sativum, or Common Pea; extensively cultivated in the United-States. 12 *fol pinnatum; foliolis bijugis:* Cassia Absus; a native of India and of Egypt. 13. *fol. bipinnatum:* Mimosa farnesiana. 14. *fol. bipinnatum:* Melia Azedarach, now naturalized in many parts of the United-States. See Part III. page 47.—15. *fol. tripinnatum:* Conium maculatum, or Common Hemlock. Common in many parts of the United-States; but if indigenous uncertain.

ADDITIONAL EXPLANATION OF PLATE I.

Fig. 2. The American Cranberry, or Vaccinium macrocarpon of Aiton: the Oxycoccos palustris of Persoon. The leaves are alternate (*folia alterna*): the corolla is campanulate, or bell-shaped (*corolla campanulata*), and consists of one petal (See Part I. page 133.), the segments of which are reflected. The stamens are generally eight in number; the germ inferior, or placed below the corolla (*germen inferum*): the fruit, a berry (*bacca*).

This plant and the Sarracenia purpurea frequently grow together, in boggy ground.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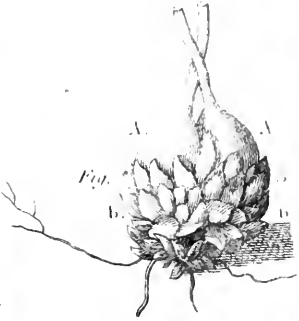
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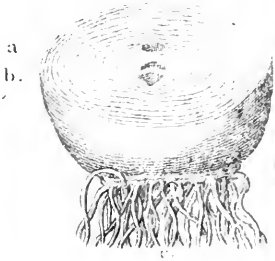
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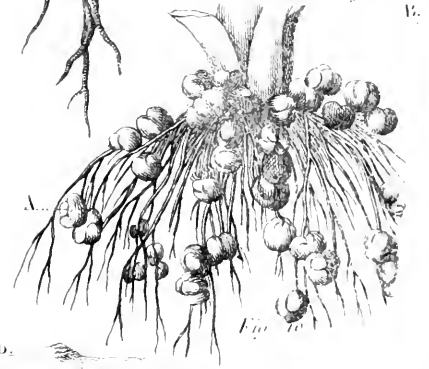
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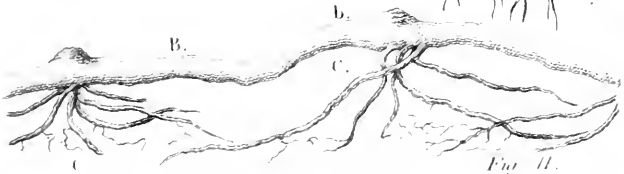
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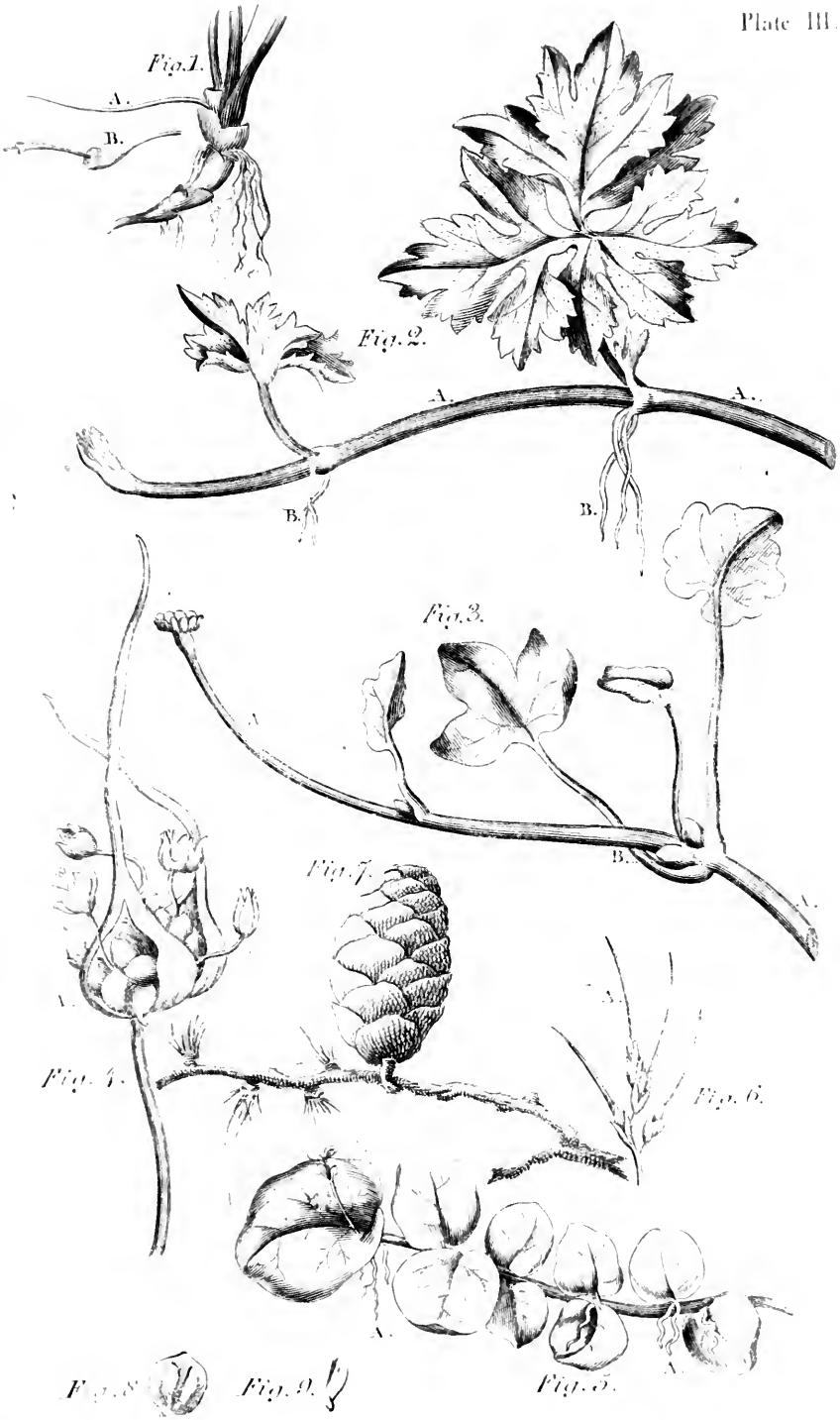
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Fig. 5.

Class XIV.

Plate IV.

Barlsia coccinea.

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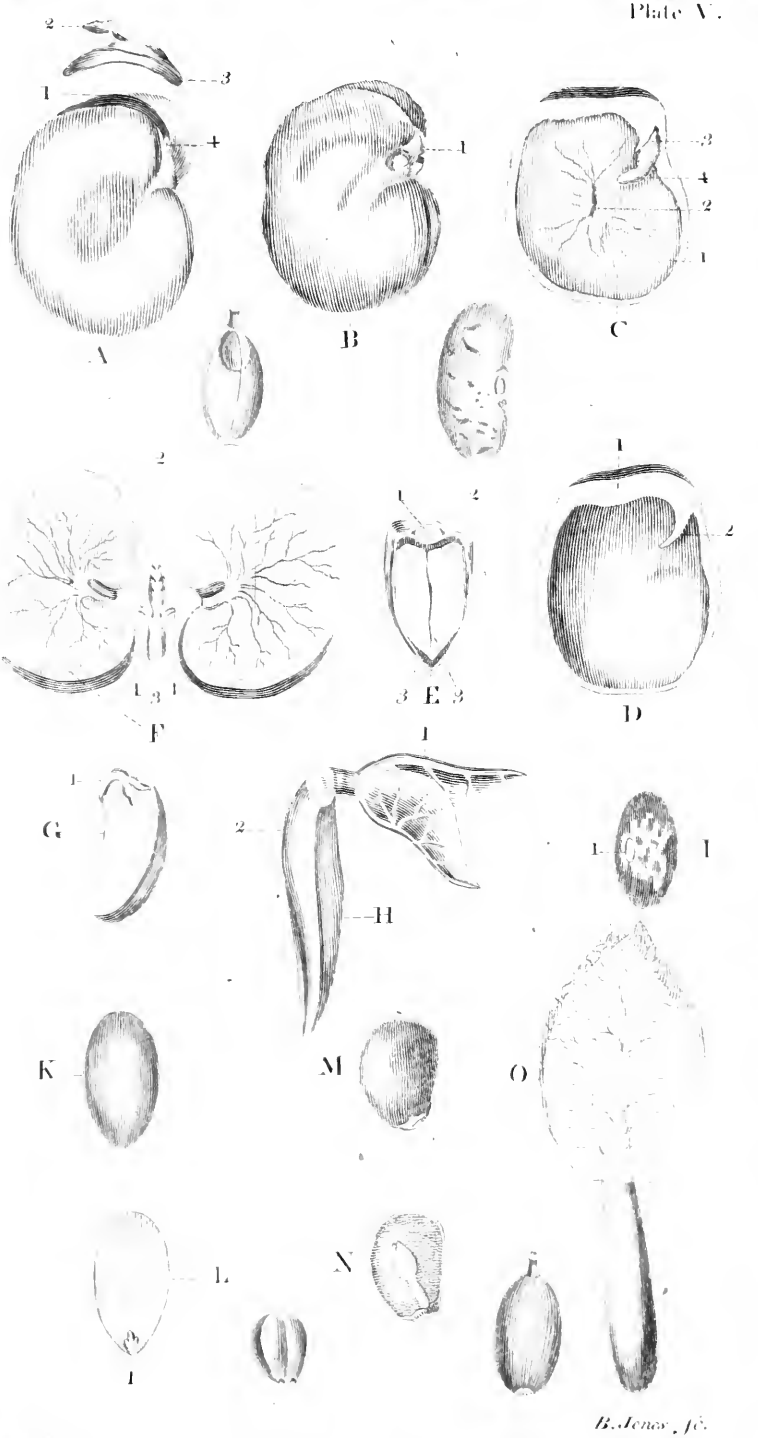
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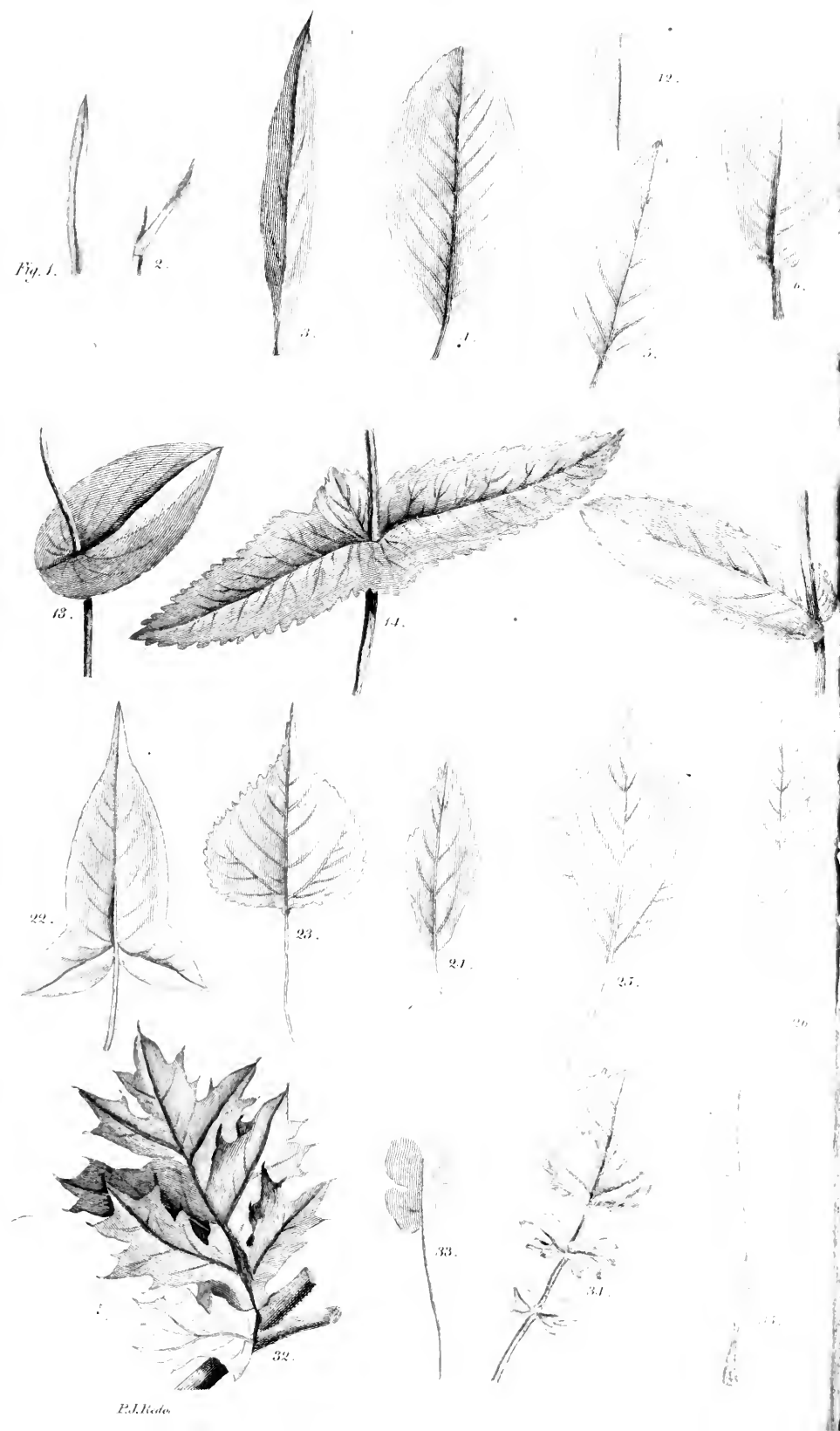
B. Jones, fc.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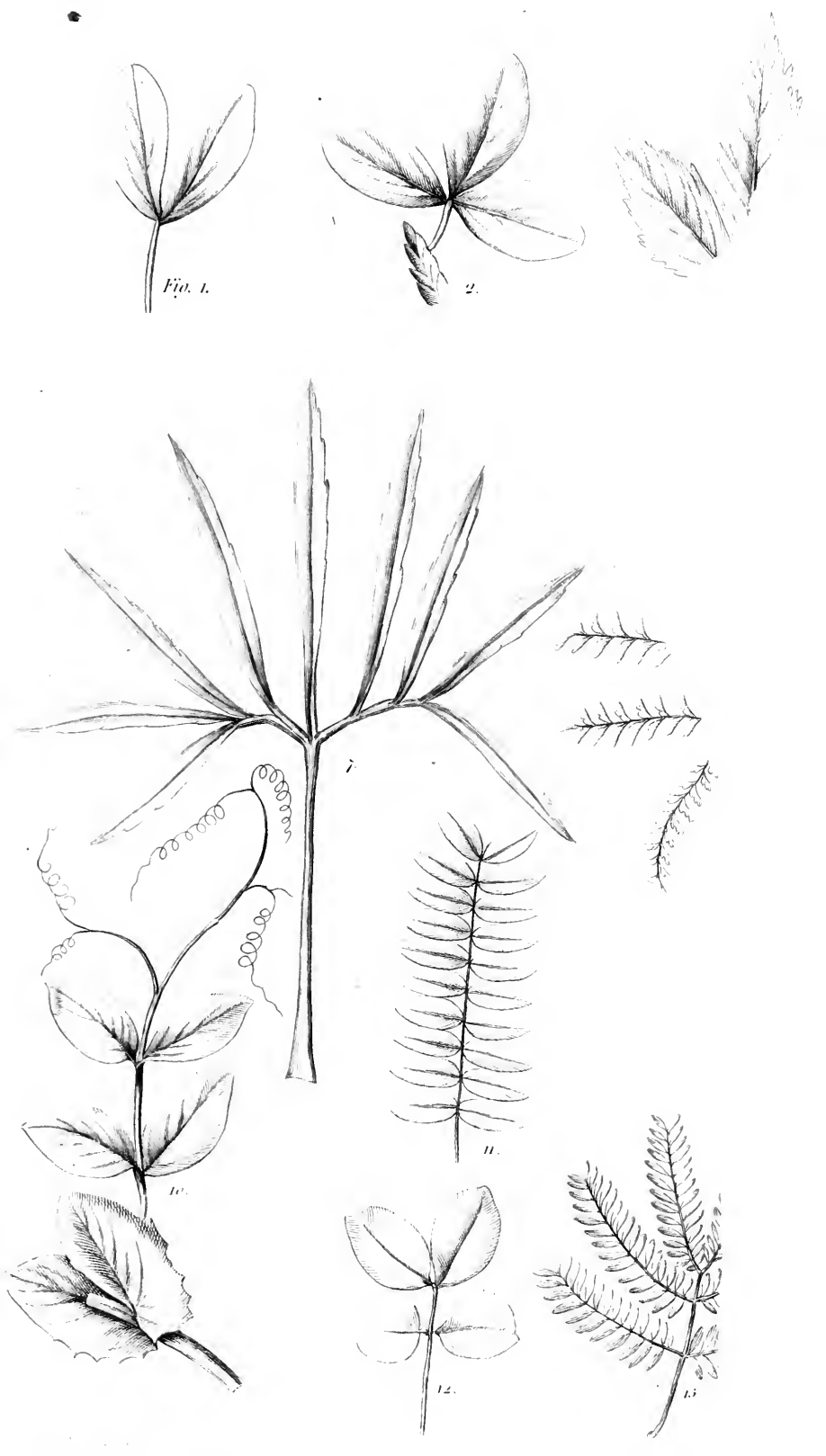
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